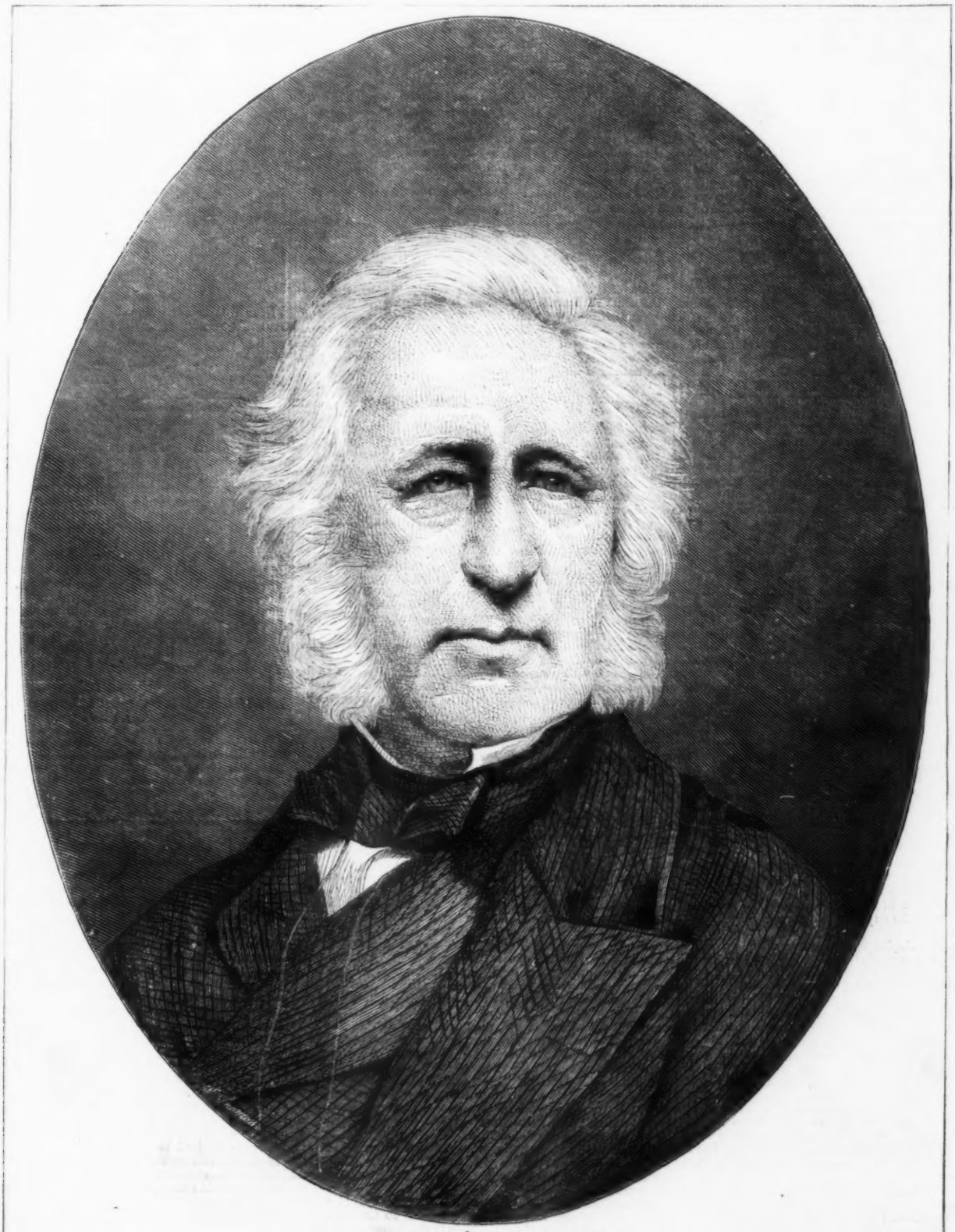
SCIENTIFIC AMERICAN SUPPLEMENT

Scientific American Supplement, Vol. II., No. 40.
Scientific American, established 1845.
New Series, Vol. XXXV., No. 14.

NEW-YORK, SEPTEMBER 30, 1876.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.
Postage free to Subscribers.



Yours faithfully
R. Napier

THE LATE MR. ROBERT NAPIER.

WE regret to have to record the death of Mr. Robert Napier, the eminent shipbuilder and marine engineer. The sad event can not be said to have been unexpected or out of accordance with the natural order of things, for Mr. Napier had certainly attained a fulness of years far beyond the age which is granted to our common humanity, and even much beyond the scriptural threescore years and ten. He was born on the 18th of June, 1791, so that when he died on Friday, the 23d of June, he had just entered the 86th year of his age. Up till about six months ago Mr. Napier had been in the enjoyment of good health almost continuously, but at that time he met with the greatest misfortune of his long life—namely, the loss of his wife, the mate of his bosom for the long period of threescore years. His grief at that great loss so affected him that he lost all interest in his former pursuits. About three months ago he became seri-

ously ill, being alarmingly affected with hemorrhage into the stomach. He recovered from the effects of this attack so far as to be able, on several occasions, to go out in a carriage for a few miles; but about six weeks ago he had a second attack of the same kind, and from this he never recovered, but grew gradually weaker and weaker till he died. He seemed to be sensible to the last.

The son of a blacksmith in the town of Dumbarton, the deceased early took to the same trade as his father, with whom he served his apprenticeship. Not only was he in a sense "born with the hammer in his hand," but he was all his life through very proud of his relationship to Vulcan; indeed, as a blacksmith, he was a "tip-top" workman, especially in ornamental smithwork, of which he remained proud down to the end of his days. He showed his fixed desire to maintain that relationship from a very early period of his manhood by becoming a member of the Incorporation of Hammermen of the Trades House of Glasgow, a body which has long been notable for embracing in its membership all the most eminent workers in iron in the city just named, and which very early in his career became Mr. Napier's adopted home. At his death he was the oldest deacon of the Incorporation, and all due respect was paid to his memory and to that fact on the day of his funeral, by his successor in the office and a full Master's Court attending at Dumbarton to assist at the celebration of the last rites in the grave-yard of the parish church where the family vault is situated.

Mr. Napier started in business on his own account in a very small way, in Greyfriars' Wynd, Glasgow, in the year 1815, when he was still under twenty-four years of age. He devoted himself to smithwork and millwright work, and was also most scrupulous in the mode of executing the commissions with which he was entrusted. It was his fixed determination from the very first to put his soul into his work, and that it should be done as thoroughly as the hammer and human hands could do it. This determination was always evidenced in his work, and its influence was a very material element in securing for the shipbuilding and engineering of the Clyde that reputation for excellence which they have long enjoyed in all parts of the world. After spending several years in the Greyfriars' Wynd smithy—long a classic spot, but now entirely cleared away by the Glasgow City Improvement Scheme—Mr. Napier saw that it was necessary "to lengthen his stakes and strengthen his cords" in connection with his business; and he took larger premises, succeeding in Camlachie Foundry his cousin, David Napier, who was one of the earliest pioneers in marine engineering. While in his first establishment he had dubbed himself "*Engineer* and Blacksmith" upon his sign at the entrance to the Wynd; but it was not till the year 1831 that he made his first engine. It was an engine of 12-horse power, built for Messrs. Davie & Boyack, flax-spinners, Dundee, where it did good work for many long years.

When he settled down in his new quarters, Mr. Napier had greater scope for putting in force his ideas as to business extension. Owing to the success of Henry Bell's first endeavor in the new art of steam navigation, coupled with that of several other steam vessels which rapidly followed it from the hands of the local shipbuilders and engineers, the Clyde bulked very largely in the public eye, and numerous orders for such vessels were received by those persons who could enter into the spirit which was rapidly taking possession of the public mind. David Napier had already done yeoman's service in the new branch of the art of construction; and when he got possession of Camlachie Foundry, Robert Napier at once resolved on following in his cousin's footsteps. In working out his resolution, he had the rare good fortune to secure the services of the late David Elder, who became the manager of Mr. Napier's works in 1821. In 1822-23, Mr. Napier began the marine engineering business, which has since become developed upon the banks of the Clyde as one of the greatest industries of the world. Much of the success of the business was doubtless due to the mechanical genius of Mr. Elder. The first order for a pair of marine engines was for the Glasgow and Dumbarton River passenger steamer Leven, which was built by Mr. James Lang, of Dumbarton, and launched in 1823. Those engines, if we mistake not, did excellent service in three steamers in succession, after which they were laid aside and preserved as an honorable relic in Mr. Napier's works. The reputation of his work soon brought numerous orders for marine engines, the building of which eventually became his special and exclusive branch of business up till the year 1843. But during the interim Mr. Napier established an imperishable reputation by the quality and extent of the work which he executed, both by the engines which he supplied to vessels sailing between various ports in the United Kingdom, and latterly by the part which he played in the formation of the Cunard Company, and by the famous vessels which he supplied to that company in the early years of its career.

For many years Mr. Napier contracted to supply vessels completed ready for sea, a happy alliance being established between himself and such famous naval architects as then pursued their career at Port-Glasgow and Greenock—namely, John Wood, Charles Wood, Robert Duncan, and Robert Steele. That was the case in respect of the Britannia, the Acadia, the Caledonia, and the Columbia, which formed the nucleus of the now famous Cunard fleet, and it was also true of the Hibernia, the Cambria, the America, the Niagara, the Europa, the Canada, the Arabia, etc. In the year 1843, Mr. Napier commenced shipbuilding on his own account at Govan, and he had already long established his great engineering nearer the harbor, first taking possession of the now historically famous Vulcan Foundry in Washington street, where he succeeded Mr. Macarthur, a well-known engineer some forty years ago, and, by and by, succeeding his cousin David Napier again, at the not less famous Lancefield Engine Works.

Doubtless one of the leading events of Mr. Napier's career is his original and long and intimate connection with the Cunard Company. Some of the finest specimens of his workmanship in naval construction were supplied to that company, such as the Persia, Scotia, and China. The ultimate success of the Cunard Company's enterprise has certainly been very largely due to the sound advice which Mr. Napier gave to the company during the early stages of its history, and to the splendid vessels which he provided, not only as the nucleus of the fleet, but also as a means of maintaining its most enviable reputation at the high pitch which it attained fifteen or twenty years ago. The history of the company may be summed up as being embraced in three epochs, each of which is an epoch in the history of steam navigation, and in all of them Mr. Napier played a prominent part as a caterer for the Cunard Company. The first of the three epochs is that of the wooden paddle steamer, which began with the Britannia in 1840, and terminated with the Arabia in 1864; the second is that of the iron paddle steamer, beginning with the Persia in 1856, and ending with the Scotia in 1862; and the third is that of the iron screw steamer, which is now flourishing.

The first vessel which Mr. Napier built was the Vanguard, a paddle steamer of 680 tons, with engines of 320 horse-power, for the Glasgow and Dublin Steam Packet Company. She was launched in June, 1843, and since then there have been launched from Napier's ship-yard at Govan well-nigh 200 vessels of extraordinary variety as to size, build, destination, ownership, etc., many of them being for mail services, and for great merchant shipping companies in almost all parts of the world. One of the earliest shipbuilding contracts executed for the British Government was the Simoom, the first of the iron screw troopships. She was built in 1849, and is still in good condition. The Erebus, the first of the armor-clad vessels ordered for the British Navy, was built at Govan in 1856; and since then no fewer than twelve armor-clads (including the Northampton, now on the stocks) have been built at the same works, six of them being for the Dutch, Turkish, and Danish navies. Since the year 1836 there have been built at the Vulcan Foundry and Lancefield, engines for about 100 government vessels of various kinds, including vessels for the British Government, the East Indian Government, and various other foreign governments; indeed, it is difficult to estimate the influence exerted by Mr. Napier (and his firm of Robert Napier & Sons) in connection with the development of the present condition of ocean steam navigation, both by vessels of peace and by vessels of war.

Robert Napier contributed more, perhaps, than any other single person to raise the shipbuilding and marine engineering interests of the Clyde to the proud and pre-eminent position they have enjoyed for many years. He lived a life of great activity until within the last dozen years or so, when he was much relieved by the younger members of his family. For many years he had the responsibilities of a great business on his shoulders, such as were quite sufficient to task to the utmost the energies of the strongest man; but he liked work, and to be thorough in it, and the world has greatly benefited in consequence. His life was one of great earnestness and singleness of purpose, and that was its value. He was a man who toiled conscientiously, and would not scamp his work, even though he might have much sooner amassed great wealth.

The funeral of the deceased took place in Dumbarton, June 27th. It was of a public character, being attended by some hundreds of the workmen (many of them old servants) employed by the firm of Robert Napier & Sons, and by large numbers of eminent shipbuilders and engineers from various towns on the Clyde, as also by distinguished university professors and well-known citizens of Glasgow, Greenock, Dumbarton, etc. Every respect due to the distinction of the deceased was paid to his memory.—*Engineering.*

THE PARIS EXHIBITION OF 1878.

THE French Senate have, within the last few days, voted the amount of 6,000,000 francs towards the construction of the Exhibition, and it has been officially announced that the works were about immediately to commence. Whether the enormous column which is proposed to be erected on the height will be finished is a question. The Acrobile, as they intend to call it, will be a permanent monument in iron, 260 metres (fancy, more than 800 feet!) high, which will serve at the same time as observatory, as lighthouse, and as a building suitable for experiments upon the velocity of light and the fall of bodies. Its altitude will exceed by more than 300 feet the highest monument of the world, which is, up to the present moment, the Pyramid of Cheops, and by nearly 380 feet the steeple of the Cathedral of Strasburg. But the building in the Champs de Mars will be a reality—a beautiful reality—although we can scarcely expect in the Exhibition of 1878 anything more perfect than the Histoire de Travail of that of 1867.

The general disposition of the Exhibition that is to be adopted is that proposed by Messrs. Krantz and du Sommerard. In the centre of the palace a vast building will be consecrated to the exhibition of the fine arts; here will be found reproductions of the great works of antiquity, which will serve to illustrate how much of the old material goes to make up the freshest novelty of life. On each side, two vast galleries will be constructed to receive the products and industrial machines of all nations. Perpendicularly to these, there will be large vestibules richly decorated, which will serve as show-rooms for objects of magnificence, and in which will be found also all the necessary indications of the contents and map of the palace. The classification of the objects exposed will be made according to their nature and nationality; on one side France, on the other foreign countries. The *allées*, of the garden, which will separate the palace of the fine arts from the galleries of the Exhibition, will be covered with a vellarium of incombustible material. As to the Trocadero, *restaurants* and *cafés* will be established there, near the exhibition of products from distant countries. The vast rotunda (capable of holding 10,000 persons) which will be constructed here, should have a very fine effect. A bridge will be built (the project is due to M. Eiffel), which will join the Champs de Mars to the Trocadero; it will be placed below the Pont de Jena, which itself will be comprised in the Exhibition.

As we have said, the final plan of the Exhibition has been agreed upon. The type adopted is M. Baudot's, modified in its details by those of the eleven other plans which were rewarded, and principally by those of Messrs. Eiffel, Coquart, and Davioud. The final execution is confided to Messrs. Krantz and Viollet-le-Duc, who will take from the project of M. Eiffel the bridge referred to above, and from that of M. Davioud the atrium. The total expenditure is calculated at 35,000,000 francs, of which 18,000,000 will be devoted to the buildings on the Champs de Mars, 7,000,000 for those of the Trocadero, 2,000,000 for the widening of the Pont de Jena, and 1,500,000 for the necessary machinery for construction and other purposes.

The surface covered in 1878 will be the quadruple that of the Crystal Palace, which seemed gigantic to the visitors to the Great Exhibition of 1851. This is the house that Paris is building, and which already there begins to take a place in its daily interests.

Those who remember the inconvenience of getting away from the Exhibition of 1867, will be delighted to hear that another capital point has been resolved upon—that of the stabling of the carriages. The city engineers have marked out the ground in the 7th and 16th arrondissements, where all the arrangements will be fully considered. We are assured, indeed, this time that means of locomotion will not be wanting, a supplementary service of river steamers and omnibuses will be organized, at the request of the city, by the respective companies, without counting two new lines of tramway and a metropolitan railway, on the London model, which it is affirmed will be opened, in so far as the part that concerns the Exhibition, in time to be of use for the visitors who will throng Paris in greater numbers than ever. The quays of the Seine will be lowered, and lifts, placed at the Pont de Jena, will raise the passengers brought by the tramways and steamers.

By the time all this is done, and the Exhibition ready to be opened, Paris will have undergone great changes, many of which will improve greatly the already beautiful city, and materially assist the comfort and enjoyment of those who visit it; but the great point that will strike those visitors who have not seen Paris for some time will be the completion, probably by the time the Exhibition opens, of the great avenue from the New Opera House to the Place du Théâtre Français, and many a narrow and dear old street will have passed away in reality, and remain but in the memory of the oldsters.—*Builder.*

THE POST-OFFICE AT THE CENTENNIAL GROUNDS.

THERE are now employed at the office (located in the southern wing of the Government Building) ten regular carriers and six clerks, with four mail wagons, which arrive and depart every hour in the day. The Centennial post-office only delivers matter addressed to persons within the grounds, all other letters or papers for the city being sent either to Station B, West Philadelphia, or to the regular city office. As the West Philadelphia Station is located on Seventieth street, below Market, and as deliveries are made every hour, a letter sent from the Grounds to any address in West Philadelphia, will arrive at its destination within two hours after being mailed. Letters addressed to persons on the east side of the Schuylkill can generally be delivered within three, or at the most four hours of mailing. This department in the Government Building is a complete working office, illustrative of the United States postal service, and foreign money order, for any part of Great Britain, Germany, Switzerland, or Canada, may be obtained the same as at the down town offices while registered letters may be dispatched for any part of the civilized world.

Near the post-office may be found the envelope machine adopted by the Government. This turns out 20,000 perfect stamped envelopes per day, the stamps being those designed especially for the Centennial year. They are sold at $3.28 per hundred, which, including the stamps, is only 28 cents for a hundred envelopes. Over 8000 per day are retailed from the Centennial post-office window.

Near this machine has been arranged all the Postmaster General's reports, from the ledger of Benjamin Franklin down to the present time; and in the same section are exhibited all the ponderous locks and other appliances used in the department since its establishment. On the west side of the building is a complete exhibit of the United States fast mail lines, this important service being illustrated by two distributing cars, adopted by the department. Here may be seen all the details of post-office work, from receiving and stamping a letter to its final start for its destination. In these cars seven clerks are kept constantly employed in distributing the mail for all points outside the city, and, in addition to the letters and papers despatched at the Centennial grounds, they also distribute all circulars mailed from the main office.

On these cars visitors may become familiar with all the details of the fast mail service, for here can be seen working models of the cars recently used on the New-York and Chicago, and New-York and Pittsburg lines, and here may also be examined all the minutiæ of transporting the United States mails. In the first car is a crescent-shaped apartment for papers, which are thrown into slanting pigeon-holes, and thence drop into sacks. Next to this is an octagonal apartment, containing 2000 boxes, into which packages for the different routes and large towns and cities are thrown. All these packages are signed with the name of the clerk who put them up, and if a mistake occurs, the clerk is made responsible for it.—*Philadelphia Ledger.*

LOCOMOTION BY COMPRESSED AIR AT THE EXHIBITION.

THE students of the Polytechnic College of Pennsylvania, at Philadelphia, have a most admirable contribution in the Exhibition in the shape of Compressed Air Locomotion.

In order to illustrate the practical working of this new system of Compressed Air Propulsion, the Students of the School of Mines and of the School of Civil Engineering united with those of the School of Mechanical Engineering of the College, in the construction of a line of railroad, both level and inclined, on which to exhibit the Locomotive.

Without fire, steam or smoke, and without cog-wheels rolling on the track, the engine ascends a grade of one foot in five, by means of a motor which, once compressed, may be kept ready for use, and be obtained through suitable conduits at any point required.

To impress upon the mind of the visitor the fact that this system is well adapted to mining purposes, a model of a section of the shaft of a mine was constructed about one foot square in its cross-section, and eight feet high, covered by the floor and framework of the ore shed and machinery house, surmounted by its belfry. Against what represents, in plaster, a rocky hillside, which rises above the summit of the mine and descends to a lower level beyond, the roadbed of the inclined plane has been built, and cross-ties laid. These ties are continued over trestle work to the abutment of a deck-bridge, one arch of which, with its supporting pier, is finished. The whole structure occupies a space 15 feet long, and is about 9 feet in its extreme height. Throughout this length a single track of rails is laid.

THE ENGINE.

The model of the engine, which has been constructed on the scale of an inch to the foot, consists of a nearly cylindrical copper air chamber, resting horizontally on four standards, which contain the journal boxes of the wheels that support the machine.

The driving wheels are horizontal, and are two in number. They revolve in opposite directions beneath the air chamber, where they are set and properly supported, one on either side of the middle of the bottom. The two horizontal cylinders and their pistons, connecting rods, valves and valve rods, do not differ materially from those of ordinary steam locomotives.

The track has a third or plate rail fastened edgewise, midway between the T rails and high enough to run between the two driving wheels. By means of a lever these wheels can be brought and retained sufficiently close together to pinch or press between them the central rail, and this pressure can be so increased as to hold the engine securely on steep inclined planes, or by the revolution of the driving wheels to propel it up or down at the speed required.

The reservoir of compressed air, under a pressure of about 30 pounds to the square inch, stands at the foot of the plane; and from it a 4 inch pipe-line is laid just outside the outer rail, and extending to the head of the plane.

In this pipe are three "air stations, one at either end of the line, and one on the plane, so that should the pressure in the air chamber fall too low, a fresh supply of compressed air may be drawn by stopping the engine at one of the "air stations," attaching a rubber pipe and opening a stop-cock.

In applying to low-grade railroads, whether elevated, underground or surface, the system of compressed air locomotion, as worked out and publicly illustrated by the students of the Polytechnic College, the middle rail of the track and the horizontal driving wheels are dispensed with, and the traction is obtained by the ordinary vertical drivers.

We are indebted to Prof. Alfred L. Kennedy, President of the Faculty, for these particulars.

PHOTOGRAPHS AT THE CENTENNIAL EXHIBITION.

NEARLY three-fifths of Photographic Hall are filled with American photographs; and when we cast a look over the same we notice instantly a great difference between the American and European pictures. Europe has sent, nearly exclusively, plain photographs (negative retouches not excepted), and, indeed, the plain pictures are the main exhibit of the European photographers; while America has exhibited a great number of life-size pictures, executed in crayon, pastel, and oil. We see at once that the position of the American photographer toward the public is an entirely different one from the European. From him the people expect work which in Europe would belong to the artist. In Europe portraits in crayon, pastel, etc., are not known as productions of photographers. Now, many perhaps will make the remark that they indeed do not belong to the line of photography; but certainly it would be wrong if we would exclude these works which are ordered, executed, and delivered in the *atelier* of the photographer. If, in America, crayons, pastels, etc., are executed in the *atelier* of the photographer, we have, of course, to judge them also. The *art* jury has, therefore, to look only at the result; the way and manner of production is a question which, for the *artist*, is to be a secondary consideration. At the Paris exhibition in 1867 they would probably have excluded these photographs, executed by the assistance of a designer, from judgment, as there the jury consisted only of photographers, who wanted the plain photographs to be acknowledged. We notice, therefore, how different the point of view is from which we have to judge the photographer, as it certainly would be for a jury consisting in great part of artists the most competent to judge about pictures in oil, pastel, or crayon.

It must be acknowledged that the Americans show an astonishing skill in the production of these life-size pictures. In Europe we would search in vain for hands to do the same. Such pieces in crayon as exhibited by Kurtz, of New-York, must be considered as first-class work; also the charcoal drawings by Sarony. Here a fine understanding of the form of nature is visible, which assists considerably in the change into the stroke manner, so necessary for a crayon. Kurtz made in this respect a further step. He has noticed very well that there exists a difference between the tint of a photograph and the tint of a crayon, which is so much more apparent when the photograph changes after some time. He therefore prefers to transfer, so to say, the whole picture into charcoal, and then to take prints of the same by means of a certain process. In this manner a whole picture in crayon is produced, whose durability is guaranteed—a progress not to be depreciated, though the fact that at last nothing remains of the photograph in the picture is of no consequence. The artist judges only the final result, and does not care about the chemical composition; and just as well, as there is nothing left in the plain photograph of the original negative taken at first.

It is well understood that in these crayons, and also in pastel and oil pictures, the individual differences of the artists are remarkably apparent—as the quiet, precise, artistical harmony of the whole by Kurtz; the effective, thorough work by Sarony; the peculiar inclination to sharp-pointed effects by Ryder (Cleveland); the conscientious work by Bradley and Rulofson, Gutekunst, Notman, and others. The manner of cutting out life-size photographs and pasting them on back-grounds to be worked over by drawing seems to me to be a difficult matter; roughnesses in the contour are too easily seen. The photographer being no artist, or having no artists at his disposal, must leave this field of work to his better-situated colleagues.

Besides these pictures, which give a peculiar expression to American photography, there are a great number of plain photographs of all sizes, showing that the American photographers are in every respect at the highest position of the art; but what many wished and expected, a characteristic new style, is not to be seen at the Exhibition. As long as such are not existing we still have to use the old styles, and, therefore, the Adam-Salomon and the Rembrandt effects are as yet performing their great part at the Exhibition. Many photographers show a predilection for them—like Anderson, of Richmond; Kent, of Rochester; and Kiewning, of Greifswald (Germany).

Yet it is much more astonishing to find that, properly speaking, the father of the Rembrandt effects, Kurtz, has disdained to exhibit them; on the contrary, he has sent a large number of plain photographs, all of which avoid the dazzling contrasts of pitch black and snow white. In their place is to be observed a mild weakening in tints, which, by the public, is considered as less effective, but which certainly will attract the sympathy of the judge of fine arts. As in lights and shades, there are also avoided all extremes in position and illumination.

A quite different character is to be seen in the pictures of Sarony; they abound with what the Frenchman calls "*chic*." We may shake the head as much as we please about the bold positions and the daring effects of light; they are *chic*ful anyhow, and they show the artist. It is surprising how well he understands how to adjust the too long and unpractical promenade size to his figures; it looks as if the size was cut to the figures. In respect to various positions Sarony produces some astonishing; he is never in want of ideas, and as he likes strong effects of light his pictures give an impression of brilliancy. We only regret that nearly all of his pictures show something of a theatrical air.

Right next to Sarony are the exhibits of Rocher, of Chicago, who this time has sent only plain photographs. He gives the most of his attention to the whole arrangement of the picture, to a stylish decoration, and a *genre*-like conception. Most of his pictures show in their selection of position and their subtle gradations of tint a certain nobleness of appearance, which make them very attractive, as in the group of the *Two Sisters*, *Before the Looking-glass*, the *Fortune Teller*, the *Lady in Rococo Dress*, and the excellent imperial border card.

The exhibits of Gutekunst, of Philadelphia, are grand. Besides large photographs of thorough work there is a long row of pictures of medium size, among them, especially, half-length pictures in cameo style, pressed out oval, and on deep, dark backgrounds, which are finely executed. There are also among his exhibits a large number of landscapes, which seem to be produced by combination printing. We think they are a little too dark, but they show that Gutekunst is an artist in many respects.

Among the portrait photographs there are backgrounds which attract a great share of attention; and hereby it ought to be mentioned that America has an artist who produces very excellent backgrounds, namely, Seavey, of New-York. I wish we had some one like him in Europe; but there, unfortunately, we are obliged to paint the necessary backgrounds partly ourselves. In deepness of tint, perspective, and plasticity of effect Seavey's backgrounds are certainly unsurpassed. Just as recognizable are his plastic firesides and similar pieces.

Kent, of Rochester, exhibited several pictures, which appear in half life-size, and, as advertised, are printed from direct negatives. Most of them are of the Rembrandt effect, and have a certain brilliancy. We find the same in Landy's pictures; but it seems to be a very precarious undertaking to try to represent the ages of man, after Shakspeare's known poem. Such a task should have its difficulties even for an artist, and can be considered as unsolvable by photography.

Landy's pictures of children are well known. Besides him, Hesler of Evanston, and Schwind and Krüger of New-York, have delivered good pictures of children. The groups of the latter have an effect of uneasiness, on account of placing things that are too light in the foreground. Mosher of Chicago, Broadbent and Phillips of Philadelphia, Bigelow of Detroit, Alman of New-York, and Bradley and Rulofson of San Francisco have delivered work in plain portraits which is worthy of acknowledgment.

Especially ought to be mentioned the enlargements of Paxon, of New-York. He delivers them plain, and seems, to judge by the exhibited specimens, to receive numerous orders from foreign photographers. If we count, besides those we have mentioned, Brady of New-York, Gubelman of New-Jersey, Wenderoth of Philadelphia, Cox of Baltimore, Hardy of Boston, Taylor of Philadelphia, Rice of Washington, Pach of New-Jersey, and Freeman of Texas, then, we think, there can be no complaint about neglecting the branch of portraits in the American department.

The landscape compartment embraces a smaller domain, though among them are most respectable pieces. In the first line stands Watkins, of San Francisco, with his Californian views. Next, following him, are Houseworth and Bradley and Rulofson, of San Francisco; they have delivered especially large prints. After them are many photographers who have taken landscapes in connection with architecture, namely, Sweeny of Cleveland, and Reid, Paterson, and Doremus of the same place. The latter, to judge by the picture, had a floating *atelier* on the Mississippi, and went with it from place to place, or followed some such original wandering existence.

Pach, of New-York, is employed in taking pictures of horses, besides landscape scenes and also outdoor groups, in which he is not without success.

Black, of Boston, has sent a row of his well-known Arctic pictures. In strong contrast to them are those of Marshall. There icebergs, here hot springs—the renowned geysers of the Yellowstone, in Colorado.

More yet is represented in the branch of stereoscopics, of which Bierstadt, of Niagara, has the greatest exhibition; he has six hundred pieces exhibited, among which are stereoscopes from all parts of the world.

Further are to be mentioned Stoddard of Glen's Falls, Reilly of Yosemite Valley, and Cremer, with views of Philadelphia and fine graphoscopes. Thorne of New-York, and Butterfield of Boston have also delivered several prints with success. Alman, of New-York, is distinguishing himself by clouds in the English style.—H. VOGEL, Ph. D., in *Philadelphia Photographer*.

NOTES FROM THE EXHIBITION.

THE IRON EXHIBIT.

IRON is the metal of the world, and the one most abundantly illustrated in all its varied forms at this Fair. Indeed, so plentiful is the display of this metal, and so generally does it form part of each national and State exhibit, that I have no hope of doing even-handed justice to the subject, and I scarcely know where to begin. The European displays are principally of the finished products in iron and steel; our own exhibits of these manufactures are confined to a few States, but are very noteworthy. Iron ores are exhibited almost universally.

BRITISH EXHIBITS.

Great Britain's show of iron work is not, on the whole, proportionate to the greatness of her iron manufacture. Among its more noteworthy features are the models of the Siemens gas furnaces in the Main Building; the great armor plates torn through by shot, which are displayed by John Brown & Sons in Machinery Hall; the work shown by the West Cumberland Iron and Steel Company, and by John Biggs, of Liverpool, who employs a new process; and the ornamental iron work in the Main Building, not far from the Elkington exhibit, which can scarcely fail to catch the eye of even a transient visitor. It is currently reported that some of the large steel manufacturers of Sheffield will shortly transfer their labors to this country, and that a preparatory investment of $100,000 has already been made near Syracuse, N.Y., with a view of establishing steel works there. Canada has an admirable exhibit of iron ores and some iron work from fifty different localities. Of these twenty-one are magnetic iron ore, fifteen are hæmatite, and ten are limonite; a first-rate catalogue furnishes every detail respecting these specimens, which will well repay study; the successes and failures of Canadian iron industry are alike illustrated, and the impression is conveyed that the smaller iron works, conducted with careful economy, have been more fortunate than the ambitious undertakings.

SWEDISH EXHIBITS.

Sweden makes the finest exhibit of iron and steel at the Fair, and, from all I can learn, the finest that has ever been made anywhere. I have the high authority of Mr. I. Lowthian Bell for saying that it is not only the most showy exhibit, but also the most complete and scientific. The system of displaying the geology of Sweden is especially deserving of praise; all the beds are represented by specimens in cabinets, arranged in the order of the rocks—primary, secondary, tertiary, quaternary, and modern formations being each by themselves, and the localities being shown by large geographical and topographical maps. A few of the specimen boxes are empty, owing, I learn, to an unfortunate loss in transportation; it is hoped that they will be filled again before the close of the Exhibition. I can imagine no quicker way for even a novice to acquire a fair knowledge of the science of geology than by the study of these cabinets. But while it is quite possible for a hasty visitor to lose sight of these cases of minerals, nobody can go through the Main Building with his eyes open and miss the magnificent displays of the Swedish iron-masters. Tall columns and pyramids, constructed wholly of the various products of the forge, form some of the most striking objects in the Fair. The collective exhibit of the Jernkonteret is, perhaps, the finest of these displays. This association embraces a very large majority of the iron-masters of Sweden, and by combining the fine specimens of their workmanship which each has contributed, they make a very effective show. The Jernkonteret also sends a complete series of iron ores and minerals; illustrations of processes, and maps of localities and mines. The Fagersta Works make a very fine display both of products and ores. Equally effective is the exhibit of the Sandvik Iron Company, including castings, shafts, car wheels, and the like. Besides the heavier display, which includes Bessemer steel, there are the lighter products of the art, such as knives, razors, scissors, etc. This exhibit is also accompanied by a series of ores. The Motala Works present an immense show, their steel products being grouped in an 8-sided pyramid. In the foregoing and several other meritorious exhibits of Swedish metallurgy, certain points are noteworthy: the articles are grouped with such skill and taste that they make a very pleasing display, in this respect surpassing any of the exhibits of iron and steel in the Fair. Among these articles there are many that specially illustrate details in their manufacture, and show the peculiar qualities of the metal, where it has been subjected to various appropriate tests. All of Sweden's show of metals and minerals is grouped in the Main Building, a circumstance which adds greatly to its effectiveness. In the Norwegian iron and steel display, the metal is shaped so as to present an ancient war vessel of Scandinavian seas, and the figure of an armed warrior on board recalls the legends of the vikings.

GERMAN EXHIBITS.

It is a step downward from Sweden's great exhibit to that of Germany, though the latter includes Krupp's enormous cannon, and provides in more than one sense some of the most striking things in Machinery Hall. The largest of the Krupp guns has a calibre of 1½ feet; it is 26½ feet long, the bore extending 22½ feet; the weight is 126,750 pounds. The bore has 80 parallel grooves, with a uniform twist of twice the whole length of the gun; it follows, of course, that the grooves do not make quite half a turn. To load the gun for a steel or chilled iron shell 275 pounds of powder are required; the shell itself weighs over 1150 pounds. Such an amount of metal might demolish a small fortification at a blow; but for service in war a few hundred pounds more or less in the weight of a shell do not probably make much difference in the feelings of the soldiers among whom it falls. I transcribe a single sentence in which a friend recounted to me the sensation in a case of the latter kind. He was with the German forces during the siege of Paris. His detachment was within range of Fort St. Valèrie, but had not yet been observed by its gunners. The first shell from the fort came unexpectedly; was aimed with precision, and exploded an instant before it fell. "It was as if a whole hardware shop had suddenly dropped on us from the sky!" It may be judged that these enormous guns of Krupp are meant for out-door work, since it is specified in respect to the largest that its carriage is intended for earth parapets of 6½ feet high; but as the whole machine—gun, carriage, and slide—weighs over 200,000 pounds, such use seems scarcely practicable. The second in size of the guns of Krupp's exhibit is called "the long gun;" it weighs 34,700 pounds, has a calibre of 9½ inches, and a total length of 17 feet. Its charge of powder and its projectiles are each about 30 per cent of those of the great gun, but the initial velocity of the projectiles differs very little. There are five other guns in Krupp's exhibit. All the seven are made out of crucible cast steel. Besides the guns there is a good show of ores and steel products, the latter including locomotive wheels and tires and two large shafts; but the military feature of this exhibit is the most pronounced, and in it there are life-size figures of horses carrying their loads for field service, and thoroughly suggestive of the business of war.

The more peaceable exhibits of iron from Germany are near Krupp's guns, and overshadowed by them. There is a column of spiegeleisen from Cologne—a square pyramid about nine feet to the side at the base and 30 feet high. The spiegel iron in the collective exhibit near the pyramid is also noteworthy, and the specimens of spathic iron ore and of the kidney ores are very fine. From the annexed territory of Lorraine, and especially from Saarbrucken, where one of the first battles of the late war was fought, there is a good display of iron and ores; from Luxemburg there are great beams of iron two feet deep and 50 feet long; a casting from Upper Silesia weighs 8750 pounds, is about 27 feet long and 7 broad. In short, the display of iron and its ores from Germany, though not arranged with as good taste as the Swedish exhibit, is fully its equal in abundance of the metal. There are some specimens of kidney iron ore in the German exhibit which are veritable curiosities; semi-crystalline forms looking like bundles of rods, or taking shapes like the miniature columns of basalt in toy models of the Giant's Causeway.

BELGIUM.

Belgium displays her iron and steel in the Main Building. Perhaps the specimens were collected hastily; they are not remarkable either for size or excellence. There is a varied show of girders, channel bars, rolled beams, splices, bolts, and railway supplies. The Société Anonyme de la Providence takes pains to let Americans know the price at which its iron products can be laid down here. The circumstance is of interest, as this is the concern which recently as "the Providence Iron Works" astonished Englishmen by opening an agency at London and taking large orders in that market.

FRANCE.

France is unfortunate in having her iron and steel exhibit scattered in different buildings. In a corner of Machinery Hall the specimens of work from the Rive de Gier district are collected, including wheels made by drop forging. There is a considerable exhibit of French iron and steel in Agricultural Hall—why there I do not know—of which great pipes and lamp-posts form part. The Marseilles Gas Company sends a quantity of spiegeleisen.

SPAIN.

Spain makes a unique exhibit of swords and other arms forged in the national armory. In Russia's department in Machinery Hall, Prince Demidoff makes a very imposing

display of heavy ironwork—rails, chains, cables, sections of cannon—besides a fine collection of ores. Near this are smaller but meritorious exhibits by his fellow-countrymen. There is less inappropriateness in putting the steel scythes of Hungary in Agricultural Hall than in some previously mentioned instances of scatteration, but few visitors would think of going there to find those implements.

AMERICAN EXHIBITS.

The show of iron, steel, and ore from our own country is enormous, but unequal, the States not being adequately represented in all instances. Let us begin with New York, as that should interest *Tribune* readers most. This letter would become a mere directory of names if it gave notice of all the exhibits of other States, but in the case of New York there are so few that it is quite practicable. The Albany Iron and Steel Company has a star-shaped display, and from Moriah, Essex County, there is a show of magnetic iron ore in the Government Building. Burden of Troy has a horseshoeing machine, and an exhibit in the Agricultural Building. There are Champlain ores from Port Henry in the Main Building—a very good display. The Albany and Rensselaer Steel Company have sent their Bessemer steel. The Rodgers Iron Company of Ausable Forks show the virtues of Adirondack metal. The Chrome Steel Company of Brooklyn has a good display. The Union Iron Company of Buffalo has three separate exhibits: in the Main Building 60 different specimens of beams, channel bars, and the like; alongside the Main Building, half a dozen specimens of beams and of bars of angle iron, one 15-inch beam being 52 feet, and one 9-inch beam 80 feet in length. The bars weigh about half a ton, the beams mostly over a ton each; all are rolled at a single heat. In the gallery at the west end of the Main Building this concern exhibits an automatic blast furnace register for recording the pressure of the blast. Besides these things the company has sent specimens of ores from three of the Lake Superior mines, and from mines in St. Lawrence and Essex Counties, N.Y.

PENNSYLVANIA.

Pennsylvania's display of iron is simply immense. The ores are well shown in the Mineral Annex, the geologic survey of the State under the excellent superintendence of Prof. J. P. Lesley having provided abundant material. For the maps, models, and minerals exhibited, the State is indebted to the efforts of John B. Pierce, a public-spirited citizen. He is Secretary of the Geological Commission of the State, but the office is not a salaried one. Coal and iron are mingled all through the mineral exhibits of Pennsylvania. It is, however, generally conceded that the best of iron ores are not found in coal regions. There is at least one exception to this rule, as shown in the display from the Broad Top coal region—a complete assortment of ores from Huntingdon, Fulton, and Bedford counties. I believe the largest American exhibit of iron is that of the Cambria Iron and Steel Company of Pennsylvania; it includes iron in all stages of ore and manufacture, and spreads over space in the Main Building, the Mineral Annex, Machinery Hall, and other localities. I am not certain whether the Government Building is thus favored. It would not be surprising, as the Black Diamond Steel Works, and Hussey, Wells & Co., of Pittsburgh, show their crucibles and products under the Government roof, as well as in the Main Building, the crucibles being partly broken so as to reveal the melted metal within. There is not room enough here to enumerate all or even the chief exhibits of Pennsylvania iron, and I break off at this point abruptly, simply remarking that to do the subject justice, the visitor must not confine himself to Division T in the Main Building, and especially must not neglect to take a look at the magnificent show of long beams and rails between that building and its annex; among these is a steel rail 120 feet in length. The steel exhibit of America is highly creditable. Commissioner I. Lowthian Bell is reported to have said that the Bessemer steel of the Bethlehem Iron and Steel Company was the finest yet made. The cabinet of ores and iron from this company deserves special notice. Planished sheet-iron, made in Philadelphia, and "Russia sheet-iron," also made in Pennsylvania, are among comparatively new American successes. The model of the Lucy furnace calls attention to an instance where the limit of size is believed to have been reached, that establishment having cost nearly three fourths of a million dollars, and having a capacity for turning out 750 tons per week. That and the Isabella furnace are the best appointed concerns of the sort in the country.

EXHIBITS OF ORES.

New Jersey has one of the most admirably arranged geological cabinets in the Exhibition, and of course her iron ores are well shown. No one firm owns so many different iron-works in that State as Cooper, Hewitt & Co. (of New York City); they make a collective exhibit. Michigan iron, especially as to ores, is admirably displayed. There are queer specimens of "brown grape iron ore" in the cabinet in the Mineral Annex that might pass for broken sticks of wood, as far as appearance goes; I suppose it is one of the freaks of "kidney ore," thus uniting the animal, vegetable, and mineral worlds in one substance. Great masses are shown of the well-known ores of Michigan—such as specular, granular magnetic ore, which is too rich to smelt by itself; and a 15-ton chunk of 66.6 per cent ore from the Cleveland Iron Company. Ohio reminds the public that she is making iron at $12 per ton in the Hocking Valley. There is also a specimen seven feet high of black band iron ore, obtained on the line of the Marietta, Pittsburgh and Cleveland Railroad. It is a bituminous shale, saturated with 40 to 50 per cent of iron. The famous Scotch pig-iron is made from exactly similar ore. Its value was first discovered by Mushet in 1801, it not having been regarded as ore previously. The whole iron industry of Scotland has sprung out of the discovery. It is a significant fact that the Bairds, of Gartsherrie, have transferred to Ohio some of the younger members of their family, and these are now making Scotch pig in America, which is not to be distinguished from the genuine Caledonian product. Missouri shows a full collection of all her different iron ores in great number and variety. Indiana's ores have been well selected and arranged with neatness by Prof. E. T. Cox. West Virginia sends iron products as well as ores in the exhibit of the Riverside Iron Company. The Woodstock Iron Company shows in the Main Building that Alabama is largely supplied with metallic wealth. Many other States are represented in the iron ores of the mineral cabinets in the Government Building. Of these the collection from East Tennessee deserves mention. Gen. Wilder has gone to an expense of over $1000 to make this a full exhibition of economic minerals from that region, giving also the location of mines, direction of veins, and topography. Some of the specimens are as big as a dry-goods box—one of the sort that the Chinamen at North Adams use to sleep in.—*New-York Tribune.*

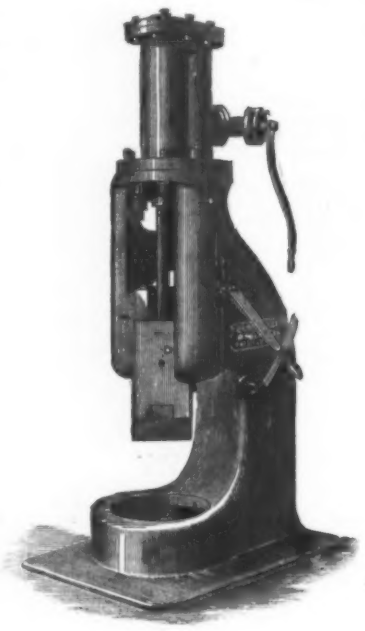


Fig. 2

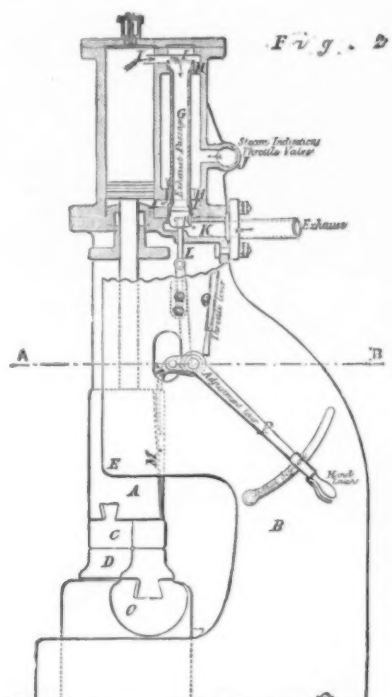


Fig. 3

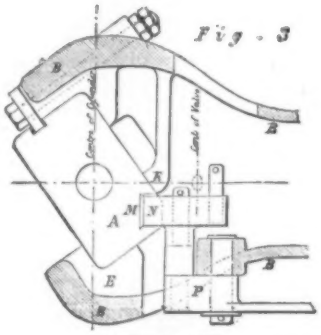
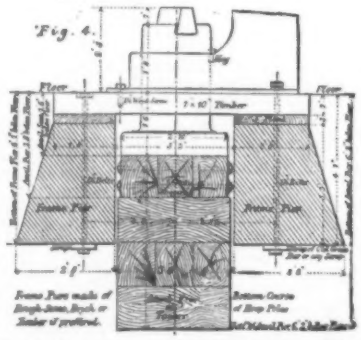


Fig. 4.



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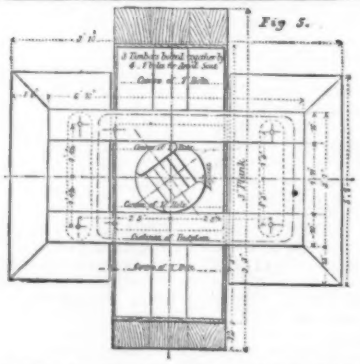


THE INTERNATIONAL EXHIBITION OF 1876.—THE FERRIS AND MILES STEAM HAMMER.

FERRIS & MILES' STEAM HAMMER AT THE EXHIBITION.

We illustrate one of the steam hammers exhibited at Philadelphia by Messrs. Ferris & Miles, descriptions of whose machines have already appeared in this journal. The hammer has a weight of head of 700 lbs. Several peculiarities of design will be noticed, the most striking of them being that the head A is set at an angle in the frame. The die C is of the oblong form shown in the drawings, as well as that of the anvil die D. The object of this arrangement is to enable the workman, after drawing out his work across the short way of the die, to turn it and finish it lengthwise without being inconvenienced by the frame. By this means skew and T-shaped dies can be dispensed with, and the full surface of the ram utilized. The latter is moved between the guides E E, and held in place by the steel plate F, bolted through the frame B. The valve G is a plain cylinder of cast iron, enlarged at each end to work in the cylindrical seats H H, in which the ports I I are placed. Steam is admitted through the valve J, and circulates round the valve G between the seats. The exhaust chamber K is below the cylinder, which therefore drains condensed steam into it at each stroke through the lower steam port. The exhaust above the piston passes down through the interior of the valves, as shown by the arrow on the drawing. The valve stem L is connected with the valves in the exhaust chamber. No stuffing box is therefore required, there being only atmospheric pressure on each side of it. This combination enables the valve to be so perfectly balanced that it will drop by its own weight while under steam.

The automatic motion is obtained by an inclined plane M upon the ram A, which actuates the rocker N, the outer arm of which is connected by a link to the valve stem, and thus gives motion to the valve. The valve is caused to rise in the up-stroke by means of the rocker N, and its connections, through the inclined plane. The steam is thus admitted to the top, which drives down the piston, while the valve and connections follow by gravity, thus reducing considerably the friction and wear upon the valves. In very quick work the fall of the valves may be accelerated by the aid of a spring; or it may be retarded in heavy work by friction springs, so as to obtain a heavier blow by a fuller admission of steam. For general work, however, the arrangement shown is perfectly effective, and as the rocker N is hung upon the adjustment lever P, any required variation can be obtained by the movement of the lever. Single blows can be struck with any degree of force, or a rapid succession of constant or variable strokes may be given.

The anvil O rests upon a separate foundation, in order to reduce the effect of concussion upon the frame. The drawing illustrates the arrangement. The bed is long, extending beyond the hammer on each side so as to give plenty of area, and the ends are left open for convenient access in case the anvil should settle and require re-adjustment.—*Engineering.*

ELECTRO-PLATING APPLIED TO TECHNICAL AND MARITIME PURPOSES.

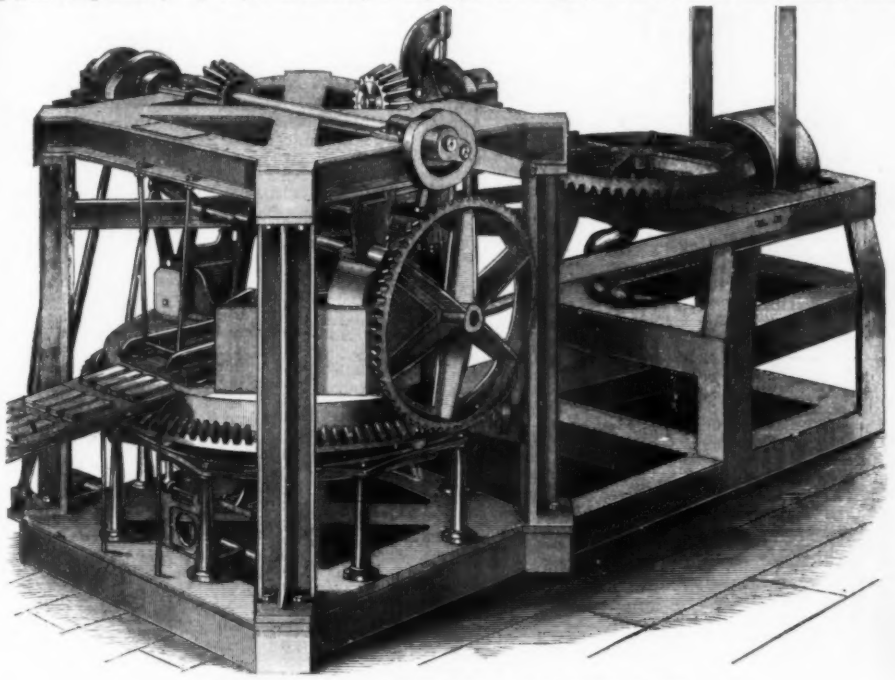
At the Vienna Exhibition the productions of the work shop at Cronstadt, in the Russian marine division, attracted deserved attention. This workshop has exhibited several objects in the Philadelphia Exhibition which are of special interest. Among others are speaking-tubes and steam pipes without seam, produced by electro-plating. The steam-pipes attain to a diameter of 12 in., and are adapted for high pressure. Then come glass articles in which the glass appears covered with a metallic layer, which is of special importance for water-level glasses. Among the finer articles may be mentioned specimens of gilding, silvering, coating with aluminium and steel by electro-plating, a zinc plate coated with iron, and other specimens of iron coating, an iron ship-screw coated with bronze, zinc articles coated with tombac, specimens of bronze coating, of glass articles coated with silver, mirrors in which a deposit of silver is substituted for quicksilver amalgam, and many other specimens in which iron or bronze coating is produced by electro-plating. Together with these objects is exhibited a model of the electro-magnetic apparatus with the bath, which serves to produce the deposit of the dissolved metal uniformly and quickly.—*Stummer's Ingénieur.*

THE LEGAL ENCOURAGEMENT OF TREE-PLANTING IN NEW-YORK.

The law of New-York State, making provision for planting shade-trees along the highway, is as follows: Any inhabitant liable to highway tax who shall transplant by the side of the public highway any forest shade-trees or fruit-trees of suitable size, shall be allowed by the overseers of highways, in abatement of his highway tax, one dollar for every four trees set out; but no row of elms shall be placed nearer than 70 feet, no row of maples or other forest trees nearer than 50 feet, except locust, which may be set 30 feet apart; fruit-trees must also be set at least 50 feet apart, and no allowance as before mentioned shall be made, unless such trees shall have been set out the year previous to the demand for said abatement of tax, and are living and well protected from animals at the time of such demand. Such legislation might well be copied in other parts of the country.

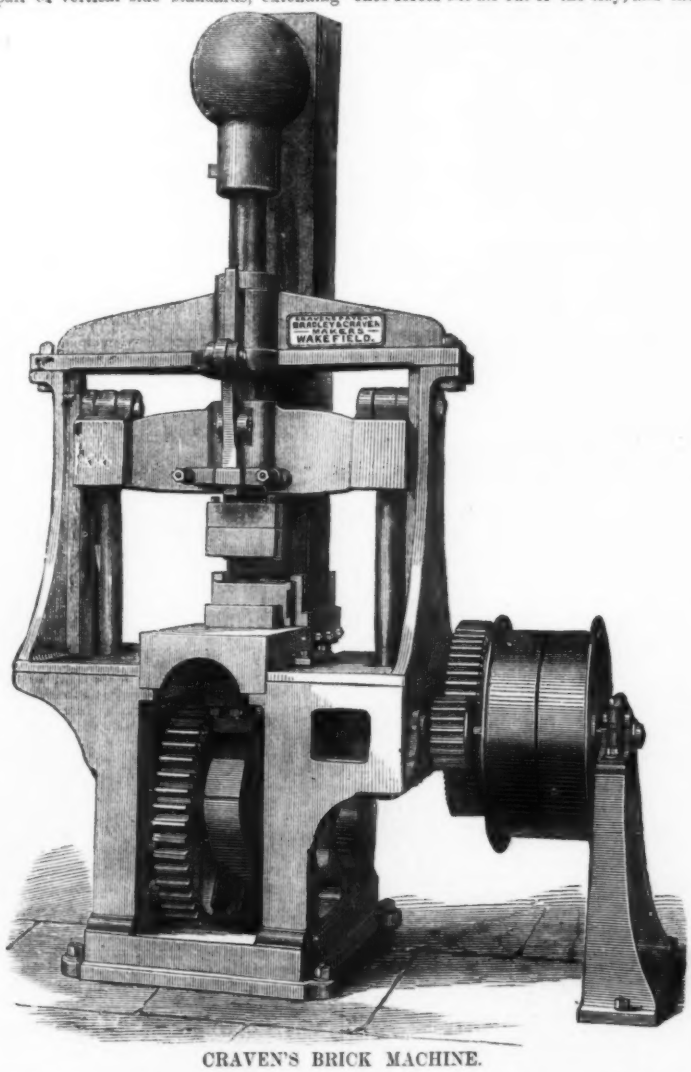
SEMI-DRY BRICK-MAKING MACHINES.

WE illustrate two forms of new brick machines, both intended to work clay in the semi-dry condition. The first example is that made by the Gregg Brick Machine Company, Philadelphia, Pa., and shown at the Exhibition. Among the advantages claimed for this machine are that it turns out the best bricks from comparatively dry clay, thus effecting a large saving in fuel during the burning operation, owing to the reduced quantity of water to be evaporated.



GREGG'S BRICK MACHINE AT THE EXHIBITION.

Our next engraving, from *Iron*, shows a front elevation in perspective of the semi-dry brick-making machine of Mr. Craven, of the firm of Bradley & Craven, of Wakefield. The machine consists of a substantial compact frame, the base-plate of which is bolted to the flooring. Rising from this plate are a pair of vertical side standards, extending laterally midway, so as to form a table and foundation-plate for the mould. The main driving shaft is fitted outside the machine, immediately below the table, its outer or free extremity being supported in a vertical bracket-bearing fixed parallel to one end-face of the main framing. This shaft carries the usual fast and loose pulleys and spur-wheel, which give motion to a pinion on a shaft extending across the centre of the machine. This shaft gives motion, by means of cranks, to a pair of strong vertical connecting rods, which traverse in guides formed in the standards of the framing. The connecting rods are united by a heavy transverse crosshead which is bolted thereto. At the centre of the crosshead there is a cylindrical opening, forming a guide, and corresponding to a similar aperture in the crosshead of the main framing above. The rod of a heavy ram or plunger passes through these guides, carrying at its upper extremity a large spherical weight, and at its lower end a plunger, which compresses the clay in the mould on the descent of the ram. To enable the pressure on the brick to be of as long duration as possible during each operation, a peculiar catch arrangement is fixed on the transverse crosshead, which, when the connecting rods have delivered the ram at their top centre, hold it there until the mould is filled with clay, when the catches are released, and the sudden fall of the ball-weighted ram at once forces the air out of the clay, and then exerts a steady



CRAVEN'S BRICK MACHINE.

pressure upon it until the connecting rods, working to the bottom centre, bring the final grip to bear upon the brick. Simultaneously with the downward movement of the plunger, an upward compressive force is exerted on the clay by means of a similar plunger or piston, which forms the lower part of the mould, and is actuated by a snail-cam fitted on a horizontal shaft, arranged in the lower central part of the framing. The grip finished, the rotation of the connecting rod removes the weight of crosshead, and the brick, still bearing the weight of the ball and ram, is forced upwards through the mould by the snail-cam. The ram is then delivered into its catches, the brick—having been released from the plunger by the action of a moving panel—is pushed by the "feeder" to the front of the table, another feed is supplied, and the operation recommences. By means of these several mechanical movements acting in combination, as we have described, it is stated that the bricks so produced are of greater density than has before been accomplished, and that manufacturers are enabled to make them cheaper than can be done by the ordinary wet-clay process, whilst the production of a single machine is not less than 7000 per diem.

THE HUDSON RIVER BRIDGE.

THE materials for the first caisson are now being delivered. The point at which the structure will cross the river is near the ferry dock, and at the intersection of the Poughkeepsie, Hartford and Boston and the Hudson River Railroads. The depth of water opposite this point averages 55 feet for a distance of 2300 feet, and vessels can approach within 50 feet of either shore. The bridge will cross the river on an east and west line, and at right angles to the river. At this point the river has a nearly straight channel for five miles in either direction. The engineer claims that a single span of the bridge would afford a free passage for all the vessels now plying on the river, without causing delays or otherwise interfering with their progress. These facts cause this point to be regarded as one of the most desirable on the river for the construction of a bridge.

The approach to the bridge on the east side is on an iron viaduct, 1800 feet in length, which passes over the Hudson River Railroad at an elevation of 160 feet. The structure across the river will be a truss bridge. The trusses will be 60 feet high, and will be built of iron and steel. There will be four piers in the river, which will be built on caissons, and the average distance from the surface of the water to the foundations of the caissons will be 85 feet. At this depth a suitable foundation for the superstructure was found. The piers will be 525 feet apart, and will be built of masonry up to the bridge seat, which is 130 feet above high-water mark. The approach on the west side is on a low truss span of 160 feet, which is built on the same plan as the bridge proper. The Bridge Company intends to build a railroad, nine miles in length, on the west side of the river, to intersect the Wallkill Valley Railroad near Gardner, by laying a third rail from this point to the intersection of the Erie Railway. The connection with the Lehigh Valley Railroad at Easton will be completed on a gauge of 4 feet 8½ inches. The engineer's estimate of the expense of building the bridge and its approaches was about $4,000,000, but the contract was made with the American Bridge Company to build the bridge for a sum considerably below this estimate, owing to a great decline in the prices of materials and labor since the estimate was made. The bridge is to have a double track for cars, a wagon roadway, and a way for foot passengers. Toll-gates will be erected at each end, and tolls collected of all who cross. The capital stock is placed in the charter at $2,000,000, with the right to increase it to $5,000,000, and the company is authorized to borrow money to an amount not exceeding the capital stock. Any railroad company is allowed to subscribe to the capital stock to an amount not exceeding five per cent of the whole, the company reserving, however, fifty per cent of the stock for individual subscriptions if they are received to that amount. The estimate of the earnings is about fifteen per cent on the estimated cost, $4,000,000. This is based on business now being offered by the Erie, Delaware, Lackawanna and Western, and the Lehigh Valley railroads and their connecting lines.

P. P. Dickinson is the Chief Engineer of the American Bridge Company, which will build the bridge and the approaches.

THE EXPLOSION ON BOARD H. M. S. THUNDERER.

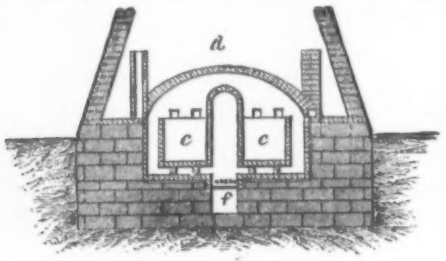
THE protracted inquiry into the cause of this disaster has ended in a verdict which in a remarkable degree corroborates the views we have already expressed in these pages. In our number of August 4 we said: "The expansion of cast-iron by heat is only one half of that of brass, and the cast-iron valve chamber has this cooler flange round it, preventing it from expanding. It will depend upon the proportion between the metal in the two parts and their respective temperatures, whether the *expansion* of the cast-iron valve chamber does not resolve itself into a *contraction* of the cylindrical portion containing the valve seat." The verdict is accordingly, "The accident, therefore, was due to the sticking of the safety valves from the *contraction* of their metal seats." The minute explanation we gave on page 105 *ante* of the way in which a safety valve that is just free in its seat when cold will become set fast when first heated, and how, until the cast-iron valve box has been uniformly heated up, the effect of increased temperature may be a contraction, and not an expansion, of the valve seat, justifies our objecting to Mr. Bramwell's statement that the experiments, which proved that a valve might be free when cold, tight when first heated, and again free when the heating is continued, were a surprise to engineers of experience. The results were just what might have been predicted, and are in accordance with our explanations published before the experiments were made. Mr. Bramwell has not in any portion of his long report alluded to the contraction of the valve seat, so that, after all, the cause of the accident has not been communicated to the jury by Mr. Bramwell, but by Mr. Phillips, one of the Boiler Committee, of which Captain Murray Aynsley, C.B., is chairman. Mr. Phillips, acting independently in the matter, tested the contraction by heat hypothesis, not for his own satisfaction, but to convince others, by boring out a heavy cast-iron ring to fit a duplicate of one of the brass safety-valve seats so tightly that the valve seat had to be forced in. He put these into a bath of tin at 450°, and afterwards allowed them to cool in the atmosphere. When cold it was found that the brass valve seat had contracted to be slack in the cast-iron. The non-allowed expansion of the valve seat had in this case produced a permanent contraction of the valve seat. At page 107, in our issue of August 4, we said: "We believe that the safety-valves of the exploded boiler were examined on the morning of the explosion when steam was rising, and we feel satisfied that the usual tests, or any test that could then have been applied, would have shown the valves to be apparently in good working order. This is the fact we wish to be grasped by engineers in the navy. If safety-valves are as these seem to have been, their condition cannot be ascertained except by opening the box and gauging each valve and its seat."

To prevent the recurrence of such a disaster, it is recommended that there should be on each boiler two small sentinel valves, in addition to the ordinary valves.—*Engineering.*

SHEFFIELD STEEL.

FOR making the best steel the best iron is imperatively demanded, and for this purpose Swedish charcoal iron is generally used.

The cementing furnace is a cupola or dome-like structure, externally resembling a glass-house, and forming a characteristic feature of the gloomy landscape of Sheffield. The lower part (with the upper or conical chimney cut off) is shown in the diagram, where *f* is the ash-pit of the fire-place, the bars



A SHEFFIELD STEEL CHEST.

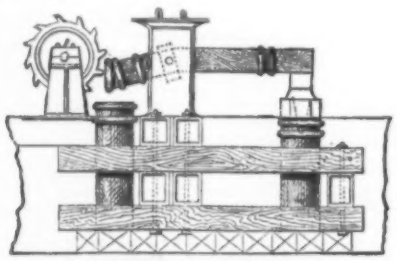
of which are shown endwise, just above the letter; *c c* are two "chests," or converting pots, shown in section. These are made of firebrick or firestone, and supporting over the fire with flues so arranged that the heated smoke shall pass up the arched space between them, and travel below them and around their outer sides, thus heating them as equally as possible. The smoky flame and heated air from the fire after traversing these flues rises into the arch, *a*, which is heated, and radiates downwards; then they slowly escape by the short chimneys on each side of the arch into the great cavity of the conical dome. The main object of all this is to steadily heat the chests with a slow-burning, semi-smothered fire, that shall yield reducing rather than oxidizing products of combustion. If there were a strong draught, the combustion would be too vivid for this, and there would be great waste of fuel by the carrying away of the heated gases too rapidly, and before they had done their work.

The chests, which are 10 to 15 ft. long, 2½ to 3 ft. deep, and about the same width, are charged with 12 to 18 tons of bars, corresponding in length to that of the chests, and usually 3 in. wide and ⅝ in. thick. The charging is conducted by first spreading on the bottom of each chest a layer of coarsely ground charcoal—that from hard wood preferred—about two inches thick, then a layer of bars with ½ to ¾ in. space between. Over these, and into the interspaces, a layer of charcoal is sifted until about 1 inch deep above the bars. Then another layer of bars and charcoal, so on up to about 6 in. of the top. Then old cement powder (that is, the charcoal already used) and grinders' waste, or "wheels waif," is moistened, and plastered over this, and the whole covered with damp sand or clay to exclude the air. The man-hole is now stopped, but some long trial bars are left protruding from the "tasting" holes.

The furnace is maintained at a glowing red or yellow heat for eight or ten days, and the trial or tasting bars are occasionally withdrawn for inspection. The progress of the cementation is ascertained by the blisters on these, and by fracture. When the carbon has sufficiently penetrated to the centre of the bars, the furnace is allowed to cool slowly. This occupies about another week.

The bars, when removed from the furnace, have their surfaces covered more or less completely with blisters, and the steel thus formed at this stage is called "blistered steel." Chemical examination shows that the iron has combined with carbon, that the quantity of combined carbon is greatest at the surface, but some of it has penetrated to the middle of the bars. The workman determines the penetration of the carbon by the grain or fracture, for the bar-iron during the cementation process loses its fibrous structure, and acquires a very fine granular or minutely crystalline structure, which is revealed by the fracture.

That the carbon should actually penetrate these solid bars of iron in this manner is a very remarkable fact. The experiments of the late Dr. Graham, demonstrating the permeability of iron and other metals, especially when heated, to certain gases, assist in explaining the phenomena of cementation, especially as it is found that a certain quantity of hydrocarbon, or cyanogen, or other carbon compounds which become gaseous at a red heat, materially assists the cementation. The use of cyanides in steel-making—(one of the profound secrets of the trade, well known to all concerned)—supports this explanation.



A SHEFFIELD STEEL HAMMER.

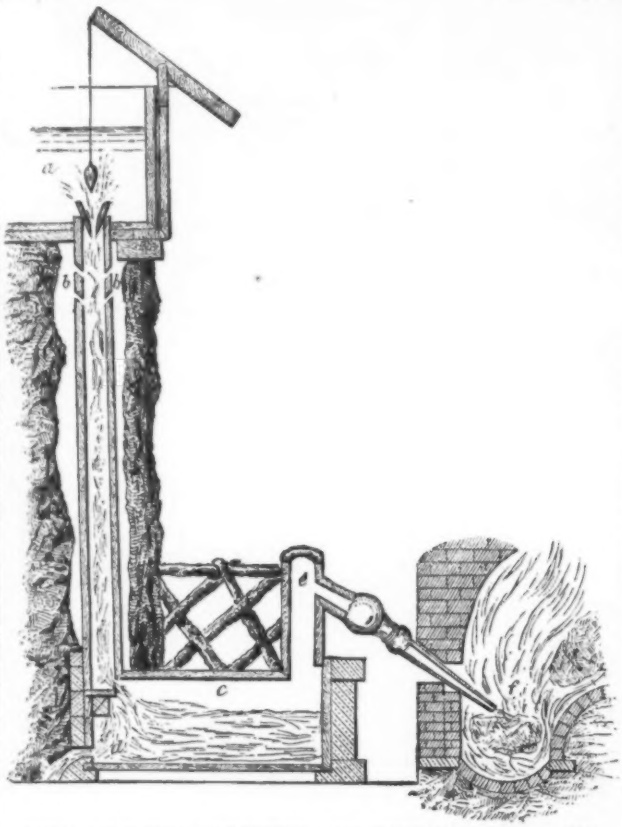
The usual explanation is that the surface of the bar first obtains, by direct contact with the charcoal, a large dose of carbon; that this superficial film then passes on a portion of its carbon to a film within, and simultaneously regains what it gave up, from the superficial carbon, as at first. Then the second film transfers some of its carbon a stage deep, and reabsorbs a compensating amount from the outside film, and so on deeper and deeper, the carbon travelling by a sort of convection until the centre is reached.

However this may be, the outside of the bar being harder and containing more carbon than the interior, and the bars being unequally charged with carbon, both as compared with each other and in different portions of their length, it becomes necessary, in order to obtain uniformity of composition, to mix these varying portions together. The most obvious method of doing this is to cut the bars into small pieces, mix them well together, and melt them. This is done in the manufacture of the best quality of British steel, the "cast steel," or "pot steel," of Sheffield. It is, however, a costly process, in consequence of the high temperature required and the consumption of fuel and destruction of crucibles. As only small quantities are melted at one time, the labor charges are also high upon every ton of steel thus melted.

So great is the destruction of crucibles, that in and around Sheffield garden walls and other structures are commonly built of old pots instead of bricks.

This process of melting is applied to the hardest or most highly carburetted steel for two reasons First, that such steel should combine hardness and toughness in the highest degree, and consequently must be homogeneous; and secondly, because it is more practicable with hard steel containing the most carbon, as this is the most fusible.

Although this is the best means of rendering steel homogeneous, it is not the only one available. A cheaper method is practised very extensively, in the manufacture of softer second-class steel. The cemented bars of blister steel are cut into short lengths, then packed together in bundles or "faggots;" these are raised to a welding heat, then hammered out with a tilt hammer striking 300 to 400 blows per minute, so rapidly that the heat of the faggot is maintained by the percussion. This bundle, thus welded into one piece, is rolled into bars, sheared, re-faggoted, and re-tilted. Steel thus treated is called "shear steel," "single shear," "double shear," etc., according to the repetition of the process.—*Prof. W. M. Williams.*



CATALAN STEEL BLOOMERY AND BLOWING APPARATUS.

CATALAN STEEL BLOOMERY.

By Prof. M. W. WILLIAMS.

STEEL made directly from the iron ore was the primitive method. In the ancient bloomeries, where pure oxides and charcoal fires were used, most of the iron contained enough carbon to come under the modern definition of mild steel, and some of it sufficient to form hard steel. It was merely a matter of more or less blowing, and varying proportions of ore and fuel, whether iron, semi-steel, mild or hard steel was produced. The same is still the case with the primitive iron workers of India, Burmah, Borneo, Africa, China, Madagascar, etc.

The Catalan, or Corsican, furnace, which is still used in the south of Europe, especially in the neighborhood of the Pyrenees, demands some further description. It is shown in the diagram, where *f* is the hearth, or furnace, in which the ore is reduced. The bottom of this is made of a sandstone capable of standing a great heat, and is lined with a coating of charcoal dust. A pile of ore—usually rich hæmatite—is placed on the hearth, and heaped up over the curved wall opposite the twyer; and this portion is arranged to lie parallel to this curved wall. The hearth is then filled up with charcoal and covered over with "*greillade*," that is, charcoal dust and small ore moistened and matted together. A gentle blast is applied at first, and when the flame bursts through the coating of *greillade* more is laid over it to check or damp the combustion, and prevent the heap of ore piled over the curve from falling in too soon. This is continued for about two hours, then the blast is turned on fully, and the cinder tapped out. The ore that was piled on the curved wall is then pushed down gradually as the lower portion is reduced, and this is continued until the whole is reduced and a mass of spongy iron formed. The bloom thus obtained is then drawn out, hammered, and rolled with very primitive machinery. Some skilful management is necessary in order to flux away the silica; this is done at the expense of the iron oxide of the ore.

Here, then, we have a miniature blast furnace, wherein the operation is stopped at the reducing zone, and the spongy iron is taken out before the absorption of impurities and subsequent fusion occurs. Steel, or hard steely iron, is usually and most easily produced. In order to obtain soft iron a greater inclination is given to the twyer, and the blast is increased. A charge of 8 or 9 cwt. of ore, containing 45 per cent of iron, yields about 33 per cent of iron; and about three tons of charcoal are used for every ton of finished iron produced. If this process were used in England, with charcoal at 50s. per ton, the cost of fuel alone would be £7 10s. per ton of iron, besides very high charges for labor.

The American or Canadian bloomery is similar. It is used in Vermont, Quebec, etc., but with a hot blast and a consumption of about 1¼ of charcoal to 1 of finished iron.

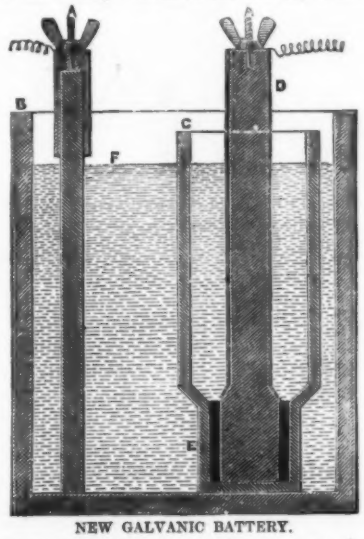
The blowing apparatus of the Catalan bloomery is a very interesting contrivance. It is called the "trompe." It is available in mountainous countries where streams of water, pouring from high levels, are abundant. An upper tank *a* is erected on a ledge of rock, or other convenient place, with one end overhanging, as shown in the diagram, where this end is supported by a tree trunk. Connected with a large hole in the bottom is a wooden tube with oblique openings in its side at *b b*. This tube connects with the top of a lower tank *c*, which has an outflow opening at *d*, and which at its upper part communicates with the twyer (made of copper) at *e*. This tank is otherwise closed and air-tight. At *a* in the upper tank is a plug that can be raised and lowered by a lever to regulate the flow of water into the descending wooden tube.

When the water is allowed to flow down this tube, its velocity is of course accelerated as it descends. This acceleration divides the column of water, and the spaces between must therefore become more or less vacuous. In consequence of this, air rushes in at *b b*, and is dragged down by the descending water, and can not return on account of the resistance offered by the fallen and broken water, which enters the lower tank by an opening suddenly contracted by the ledge shown above *d*. Thus there is a continual inflow of air as well as water to the lower tank, and a consequent pressure of air which produces a blast through the twyer. The pressure is regulated by the quantity of water allowed to fall through from the upper tank, and may be increased until it is so great as to overcome the falling water and drive itself back again up the tube. When the inflow and outflow of water at the lower tank are equal, the blast remains steady; when the inflow is in excess its pressure increases, when less it diminishes. One defect of this arrangement, otherwise admirable, is that the air of the blast is supersaturated with water, and even carries some spray. The ascending chamber at *e* allows much of the spray to settle down before entering the twyer.

IMPROVED GALVANIC BATTERY.

THIS arrangement of a galvanic cell by Messrs. J. C. and G. Fuller, of Fenchurch street, London, has for its object the improvement of batteries as regards their constancy and regularity of working. Hitherto, according to the inventors, it has been usual to employ a bath of mercury into which the zinc plate is so far inserted as to admit of capillary action taking place on the surface of the zinc plate; nevertheless, irregularity in the power and rapid diminution of the same take place, so that this means does not completely fulfil the object aimed at. This invention, however, improves the regularity and prolongs the lasting power of the battery by the employment of a column of mercury contained in a porous diaphragm or cell, into which the zinc plate is plunged. In the figure, which is a sectional illustration of the new cell, A A are the poles of the battery; B is the outer vessel, in which it has hitherto been customary to place the mercury and the zinc plate; C is the porous diaphragm or cell in which is placed the mercury or amalgam of zinc, and the zinc plate or any other conductor standing in the mercury or amalgam.

In order to further improve the constancy of the battery the inventors prefer to, more or less, cover any part of the zinc plate or other conductor which is not required for chemical action, with a coating of any suitable insulating material, and thus protect the zinc against the exciting fluid of the battery. D shows the insulation of the zinc (or other conductor). The uninsulated portion of this zinc plate is inserted in the mercury or amalgam, only so far as is found to be necessary for the perfect action of the battery. E shows the mercury or amalgam in



NEW GALVANIC BATTERY.

the porous cell, while F is the exciting fluid of the battery. The invention may, it is stated, be varied in its details to suit the requirements of any form of galvanic battery; but it is specially useful when applied in conjunction with bichromate of potash dissolved in sulphuric acid and water.

TO RE-VARNISH NEGATIVES.

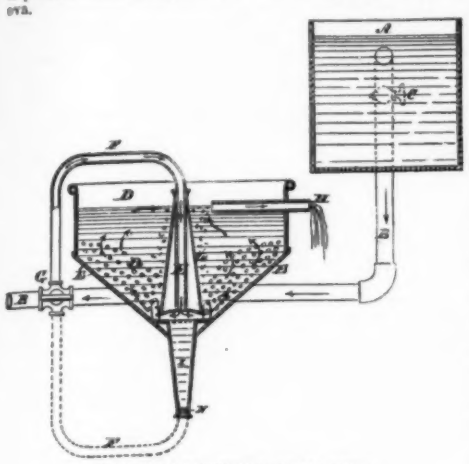
FOR the benefit of those who wish to remove the varnish from negatives the following plan, which has been highly recommended, is offered:—Pour a saturated solution of two parts of alcohol to one part of cyanide of potassium over the plate and keep moving it about until the varnish dissolves, which it will soon do. Wash and dry the plate, then re-varnish and treat as a new negative. This method is said to be superior to the alcohol bath, ammonia and alcohol, potash and alcohol, or even alcoholic vapor; but if the negative have been intensified with chloride of mercury the cyanide of potassium must not be used.

IMPROVED FISH-HATCHING APPARATUS.

By S. WILMOT, Newcastle, Canada.

HERETOFORE the receptacles have been provided with a wire screen, for the purpose of preventing the eggs from liability of removal with the overflow.

In my improvement I dispense with the screen and keep the perfect eggs within the receptacle by regulating the force of the flow of water so as not to lift them to the height of the overflow, only deleterious lighter substances being raised to a sufficient height to pass off with the overflow, the object of my invention being to cleanse the ova and separate the perfect from the imperfect eggs in the process of hatching, and to prevent sediment in the water from being deposited on the ova.

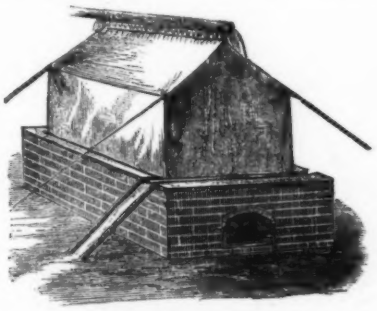


NEW FISH-HATCHING APPARATUS.

The water from the reservoir A, by a connection of pipes, passes through the tube E downwardly into the bottom of the hatching basin D, or upwardly through the tube I, in each case the water being discharged into the basin at or near its bottom. The water, striking against the bottom of the basin in the one case, and the bottom of the tube E in the other case, glances off uniformly around the slanting sides of the basin, carrying up with it the ova or eggs O, which, following the current, then roll toward the tube E. The heavy or sound eggs fall to the bottom of the basin at the sides of the jacket or tube, to be again moved by the circulation of water. The light or imperfect eggs, together with sedimentary substances in the water, pass up the outside of the jacket by the upward flow, and are carried off with the waste water through the spout H.

IMPROVEMENT IN CONDENSERS.

WE give a sketch of a patent condenser for cooling heated vapors or fumes, invented by Charles B. Dahlgren. The principle consists in constructing the condensing chamber either partially or wholly of an absorbent material, which is kept constantly saturated with water so as to produce a refrigeratory effect inside of the chamber by the evaporation of the water from the surrounding surfaces. An application of the improvement may be made in connection with an ordinary retort for separating quicksilver from gold and silver amalgam.



NOVEL CONDENSER.

In the base of the retort, which can be constructed in various ways, is an open basin or retort, in which is the amalgam to be retorted. Under the basin is the furnace, etc. Upon the base is constructed a simple framework which is capable of supporting a housing, which is made of canvas or other absorbent material. In the base is a channel which extends entirely around the retort, and this channel is kept filled with water. The housing is so suspended or adjusted that its lower edge will enter the water in the channel, and thus prevent the escape of any of the vapors. Above the housing are perforated water pipes arranged so as to allow a constant spray or stream of water on the housing, and thus keep it saturated. The surplus water will flow down the sides of the housing and be caught in the channel into which the lower edge of the housing dips. A waste pipe carries away the surplus water.

The evaporation of the moisture from the housing will make a refrigerating action inside the chamber, inside of which the fumes are generated or delivered, so that they will be condensed inside of the housing and flow down its sides into the channel. A condenser of this kind can be applied wherever it is desired to condense vapors or fumes. It can be cheaply constructed, while it is claimed that its action will be superior to that of any of the ordinary methods of condensing vapors.—*Mining and Scientific Press.*

THE DOCTRINE OF EVOLUTION.

AMONG the most interesting of the papers read at the meeting of the American Association for the Advancement of Science, at Buffalo, in August last, was that of Prof. E. S. Morse, Vice-President, on the subject of Evolution. According to the report in the *New-York Tribune*, he thinks that the time for being mealy-mouthed in this matter is past. Especially is credit due to the American workers in this field of research. The main object of the address was to show what America had contributed toward the growth of the Development Theory.

He said that never before the present period has the study of animal life assumed so high dignity among the sciences. Chemistry could long since point to her triumphs in the useful arts; geology to the revelations of hidden wealth below the surface; but zoölogy was only valued as an adjunct to geological studies or looked to as a means for averting the ravages of insects. Now, the question of the origin of man is answered by the revelations from animal forms. No general review of American studies in this field has hitherto been attempted. The works on the subject which meet the popular eye are from English and German sources. Their references are largely composed of European observations, and the public has commonly inferred that these are the principal examples. Their remoteness prevents these evidences from carrying due conviction. Our native researches lie concealed in the proceedings of learned societies, and are only in a few instances made accessible to the ordinary reader of the literature of the day.

The development of zoölogical study in this country presents itself under two aspects. The first and earliest was the period when its votaries busied themselves with making an inventory of animals and plants, and arranging them under schedules of genera, species, and varieties. Very necessary work was this. Prof. Agassiz likened it to the labor of bringing together the stones and bricks for a building. But these workers piled up their materials thus accumulated till they shut out the light of knowledge and offered a barrier to those who would have built the edifice of the science itself. The words of Emerson describing science in England in 1847, were true of this country at a later date: "One hermit finds this fact, another finds that, and lives and dies ignorant of its value." The change from this period of preparation to one of direct work in building up the science of zoölogy dates from the arrival of Prof. Agassiz in this country and the vast popular interest which attended his efforts to kindle the growth of knowledge. These efforts were largely directed toward elevating the character and aims of the papers contributed to our learned societies, and the success he met with was as noteworthy here as in the arena where he was more generally known to the public. Prof. Agassiz made men. Previously they had been the slaves of their science, the mere hewers of wood and drawers of water. He taught Americans what Cuvier, Von Baer, and Leuckart had been doing. He urged, indeed, his hearty protests against evolution theories, but thereby he did good service in awakening attention to the subject and compelling further inquiry. Since then all the students whom he educated personally have, with scarcely an exception, become converts to those theories.

NATURAL SELECTION AN AMERICAN DOCTRINE.

The first clear premonition of the doctrine of natural selection came from this country, or rather from an American, Wm. Charles Wells, born at Charleston, S. C., in 1757. This appears in a paper which he read in 1813 before the Royal Society. It proffers an explanation of the color of dark-skinned races of men. He cites the changes of animals under domestication, shows that varieties in men and animals were occurring exceptionally but constantly; that different breeds of animals were thus obtained by man's selective supervision; that a similar selection among men had been effected by the comparative immunity from certain diseases of those who had dark skins.

TRANSMUTATIONS OF SPECIES.

As evidences of the transmutation of species, Prof. Morse here cited the instances where the seeds of Alpine plants sown in warmer regions gradually produced plants that had previously been regarded as of a different species. A kind of crustacean was similarly changed from one recorded species to another by gradually freshening the briny water in which it lived; in slowly altering thus it actually lost one of its segments. Mr. James Lewis discovered that a truncate form of mussel which had thus been distinguished from another form had taken its peculiar shape from the circumstances to which it had been exposed, namely, the abrasion of its edges and consequent retarding of its growth in the rapid currents of the Mohawk River; he also made similar observations on other mollusks under other influences. A. G. Wetherby called attention to changes of the kind in snails under like surroundings. Prof. Agassiz urged that what are called "varieties" by naturalists do not really exist separately. He found a series of echinoderms in which the forms were graded insensibly from one to the other. The extremities of the series would have been called distinct species. Prof. Parsons suggested that species might be done away with if all intermediate forms should be discovered; and Dr. Gray expressed the belief that all species might be thus eventually resolved into varieties. Dr. J. G. Cooper and Messrs. Stearns, Bland, and Birney each described instances where such changes in animals followed altered circumstances of heat or moisture.

In a broader field and respecting different classes of creatures, Prof. S. F. Baird, J. A. Allen, and Robert Ridgway have severally found that marked differences in birds and mammals are due solely to their surroundings. Birds bred at high altitudes or at the North were thus shown to be smaller than those of the same kind at the South or at lower elevations; Western birds have longer tails than Eastern ones of the same species; the bills increase in size below a certain latitude; on the Pacific coast the birds acquire a darker hue. Similar changes in the ears and feet of mammals, as well as in their fur, are noted as dependent on climate. When these changes were tabulated and shown on a geographical chart, they were found coincident with variations already ascertained in the annual amount of rainfall in the different regions. The total number of species of birds was reduced about a fifth by these investigations; the number of species of squirrels diminishes one half or more. Dr. A. S. Packard sees that this process of reducing species must go on while the gaps between them are gradually filled, and the genera must follow in this process of obliteration. He says: "The work of the systematic biologist amounts to little more than putting nature into a strait jacket."

In producing new evidences for the doctrine of natural selection, Dr. Burt G. Wilder has borne a distinguished part. Anatomical changes have been closely observed. To this class of students belong also the essays of Dr. William K. Brooks, Dr. Englemann, and Prof. Charles V. Riley. Prof. Riley's proof of the interdependence of flower and insect in the case of the Yucca moth is one of these triumphs. Prof. Grote has made a noteworthy observation on the alterations caused by use or non-use in the antennæ of the butterfly. One of the most striking instances of the better knowledge which closer observation of nature has conferred is that of the shape of the honeycomb. In the days of the Bridgewater Treatises it was demonstrated that the form of the cell, mathematically considered, was that which used space and material to the greatest possible advantage. The late Prof. Jeffries Wyman spoiled this pretty theory by showing that a cell of this mathematical perfection is rarely, if ever, made. The cells are built unequally and in the greatest variety of shapes, due to incorrect alignment and many other causes. There is no geometrical accuracy about the structure. Following the list of cell-making insects, from wasps, hornets, and humble bees upward, we find that there are all grades from shapeless cells to those that approach but never reach perfection. Prof. Wyman showed remarkable ingenuity in this research, making plaster casts of the comb, dissolving out the comb from the plaster, then cutting sections and taking electrotypes. The late Prof. Chauncey Wright was almost equally fortunate in showing that the arrangement of leaves of plants along their axes was due to circumstances of growth, and not a result of blind law.

Among the examples of the survival of forms by adaptation to changed environment, Prof. Morse mentioned the discovery by Ernest Ingersoll of marine mollusks and living salt-water crabs high up in the Rocky Mountains. Some of the crabs were closely related to existing marine forms. The researches of Prof. Marsh concerning the siredon, an animal of the salamander kind, that loses its gills and becomes, when moved from its native habitat, one previously recorded under an entirely different genus (amblystoma), has been described and figured in one of the earlier Extras of the *Tribune*. For many years Prof. Agassiz argued that the blind fish of the Mammoth Cave were a race created in their present condition. This whole matter has been removed from discussion by the accurate investigation and thorough researches of Drs. Packard and F. W. Putnam, and a series of fishes, from those with perfect eyes to those without any, including between them various deficiencies of vision, has been found in American caves and secluded waters. The discoveries of Profs. Alpheus Hyatt and E. D. Cope respecting the ammonites, were almost simultaneous, showing a parallel between the changes of form in groups and in the separate individuals. The numerous writings of Prof. Cope on evolution doctrines deserve notice here. But we must hasten on to the great discoveries among the Tertiary mammals of the West by Profs. Leidy, Marsh, and Cope. They have filled wide gaps between older and existing forms, showing all the intermediate animals, so that we have nearly the whole ancestry of the horse, for instance, back to the five-toed animals not much bigger than a fox in the early Eocene.

EVOLUTION OF MAN FROM ANIMALS.

The positions taken by the earlier workers in zoölogy were then reviewed, and the latter half of the address set forth the present theories of Darwin and the evolution school. Prof. Agassiz was driven to the expedient of belief in several different creations of men, in order to preserve his faith in the separate creation of animals, and was heartily reprehended for his views by the religious controversialists of that period. Since those days innumerable facts have been brought to bear upon the controversy. Many of these were mentioned in detail by Prof. Morse, but on the point as to the gradual development of the intellect of animals, the discoveries of Prof. C. C. Marsh in respect to the small size of the brains of the earlier mammals are especially worthy of attention. He has shown that the animals of the earliest Eocene formation have brains so small that they may be likened to those of a serpent, and relatively so diminutive that they can be passed through the neural cavity of the backbone. As we go upward in the strata the size of the brain steadily increases. Its development in the monkey tribe is regarded as the means by which those animals were enabled to escape from the carnivora that then abounded; and intellect even in that era became superior to brute force. Due justice can not here be done to the chain of argument by which Prof. Morse illustrated the descent of the human race from ape-like forms. The principal feature in it was the prominence given to the intellectual needs and consequent development of the monkey. In respect to man, the necessity of care during the period of infancy was strongly dwelt upon; and it was shown that the long period during which young human beings have to be supported and cared for lies at the foundation of the family and of social life. Due credit was given to the workers in this field who have traced out, step by step, the necessities which are occasioned by the long continuance of human infancy, which calls forth alike the sympathies and the efforts of the parents. None of the interior animals are long in acquiring the capacity for walking and procuring food. The monkeys, within a month of their birth, are as capable of walking as at mature age. Man, in his physical powers, is weaker than any of the lower animals that compare with him in size; his strength is in his intellect.

A mind unbiased by preconceived opinion can scarcely resist the convictions that will be forced upon it by nature's facts as to man's lowly origin. The massive skulls and coarse ridges for muscular attachment, the rounding of the case of the nostrils, the early ossification of the nasal bones, the small cranial capacity in certain forms, the prominence of the frontal crest, the posterior position of the *foramen magnum*, the approximation of the temporal ridges, the lateral flattening of the shin-bones, the perforation of the humerus, the tendency of the pelvis to depart from the usual proportions—all these are characteristic of the earlier races of men. Associated with these race forms there is a rudeness of culture and the manifestation of the coarsest instincts. He must be blind indeed who cannot recognize the truths to which these evidences point.

We need no longer be surprised at the fatalism of the Turk, the cruelties practised by lower races, or the outrages that are attributed to total depravity among civilized men. They are not instigated by an evil spirit, but are the outburst of the savage nature inherited from their animal progenitors, and are still preserved more manifestly among the lower races of to-day. We are taught the folly of permitting criminals to roam at large or receive the benefit of legislative pardon. Society owes it to itself to keep its criminal classes in a confinement where they can not propagate their kind.

THE STUPIDITY OF ANIMALS.

Mr. St. George Mivart, in his recent "Lessons from Nature as Manifested in Mind and Matter," argues with great force that man differs fundamentally from brutes, and that his origin, so fa as regards his mind at all events, is distinct from theirs. Brutes are said to be wholly devoid of reason, and the various cases adduced by Mr. Darwin and others as proving the contrary are carefully examined. An important point is made of the fact that, as we pass from the lower animals to those forms which, physically, most resemble man, we find no corresponding approach to him in mental powers. The anthropoid apes are in no degree more intelligent than the dog, the horse, the elephant, or even the beaver; while the instances of apparent intelligence in the actions of insects, and even of snails, place them, in this respect, on a level with the gorilla. Mr. Mivart thinks that a book requires to be written on "the stupidity of animals," to balance the tendency to exaggerate so-called animal intelligence.

THAT REMARKABLE RAILWAY ACCIDENT.

A FEW weeks ago in the SCIENTIFIC AMERICAN we published the engraving, herewith again presented, of a remarkable railway accident, which was then stated to have occurred a long time previous, but no date or particulars were given. Nothing was then known except that it must have been a veritable occurrence, because the engraving was made from a veritable photograph evidently taken on the spot. At the time of publishing the engraving we requested any of our readers who might have knowledge of the occurrence to communicate the details. In reply to this request we received a considerable number of letters, some of the parties locating the scene of the accident in one place, some in another, some expressing doubts as to whether it ever took place, and others, especially wise in their own conceit, giving reasons why it could not have occurred; others ridiculing the idea of such an accident, etc. Finally, we received from authentic sources full particulars in detail, with dates, names, etc., which we will now present, prefacing the same, as curiosities, with extracts from some of the various letters mentioned:

TO THE EDITOR OF THE "SCIENTIFIC AMERICAN":

The railroad collision described in the SCIENTIFIC AMERICAN I think must be the one that happened on the Toledo, Wabash and Western Railroad, on the Decatur and St. Louis branch, five years ago this summer. A similar one occurred there: one train was freight, the other construction, and nine men were killed in the car of the construction. Both engineers and firemen saved themselves by jumping. The engines were in about the same shape that these are. On those, however, were the letters on the tenders, "T., W. & W.," and one was numbered 153, and was built by Wm. Mason, of Taunton, Mass. I don't remember the number of the other, but it belonged to the same road. Their shops are at Springfield, Ill.

G. H. F.

TO THE EDITOR OF THE "SCIENTIFIC AMERICAN":

A collision similar to the engraving occurred on Sept. 10th, 1872, on the Niagara branch of the New York Central and Hudson River Railroad, about a mile and a half east of the village of Albion, N. Y. Both engines were interlocked as shown in the engraving. The freight train bound west was behind time. The train east started from Albion, intending to meet the other freight at next station. Time of collision about 5 A.M.

E. H.

TO THE EDITOR OF THE "SCIENTIFIC AMERICAN":

Your engraving and article entitled "A Remarkable Railway Accident," in the SCIENTIFIC AMERICAN, reminds me of another very similar accident which occurred on the N. Y. C. two miles east of Albion, some time in 1872 (the exact date of which I am unable to give at present). An emigrant freight bound west left Murray about three o'clock in the morning, intending to meet another freight bound east at Albion. The westward-bound train being behind time, the conductor of the eastward train concluded to run to Murray, the next station east, the result being a collision.

The track was a straight line, though there was a curve a short distance from the place of the accident, which was probably the direct cause. The two trains collided upon an embankment about fifteen feet high. Both locomotives were forced into the air, and stood perpendicularly each upon its own tender, which had been driven under it by the momentum of the loaded cars behind. The smoke-stack of one remained in place, but that of the other was torn off, which locomotive also seemed to receive more injury about the front end of the boiler than the other. The cars which were telescoped and crushed upon the locomotives took fire from the furnaces, and six, I believe, were consumed. The cars and rubbish on one side were cleared away, and a powerful locomotive was attached by means of cables to the tender of one of the locomotives that had collided, and it was not until after several unsuccessful attempts to pull them apart that they could be induced to yield their embrace. The breakage was not so apparent as the bending, twisting, and interlocking of the parts. None of the hands on either train were injured, all having saved themselves by leaping from the trains.

A photographer was on hand, but owing to an accident to his apparatus he was unable to obtain a negative.

By a slight stretch of the imagination your engraving would answer for that which occurred at Albion, as it resembles it very much.

The trains were running at full speed at the time of collision, and the sight of two locomotives in the position into which they were forced was grand in the extreme, and hundreds of persons from Albion and vicinity witnessed the scene.

The road was obstructed about six hours.

C. F. L.

TO THE EDITOR OF THE "SCIENTIFIC AMERICAN".

Your "Remarkable Railway Accident" looks more like a clever hoax than any thing else, where the scrap-pile of the yard has been overhauled for the purpose of composing a striking picture. Before taking his negative, however, the artist should have had some experience in collisions, or consulted with some one who had—say a member of Sherman's army who was at Columbia, S. C., and helped destroy the locomotives there collected and unable to move further northward on account of the change of gauge. The top-heavy smoke-stacks would then not have been allowed to remain standing uninjured in their places, for they are readily displaced by the shock of collision. The very absence of names from the locomotives, where they are generally so prominently displayed, is certainly a good cause for suspicion as to the genuineness of pretended accident.

A. C.

TO THE EDITOR OF THE "SCIENTIFIC AMERICAN":

Did you *see* the photograph of the two engines in collision; and do *you* believe that such a collision would leave *two* smoke-stacks with heavy tops standing in their original position on the engines, or very nearly so? Do *you* believe that that cattle car settled quietly into place against the tender, with not a shattered post or bar? Your inquiry is very pertinent: Where did it occur?

R. L. N.

TO THE EDITOR OF THE "SCIENTIFIC AMERICAN":

You give an engraving of a singular railroad accident, purporting to be a correct copy of a photograph taken at the time it occurred.

RAILWAY ACCIDENT AT FRANKLIN GROVE, ILL., CHICAGO AND NORTHWESTERN RAILWAY.

In taking the picture, you give the number C 3443 on the rack car, and ask that some of your readers give you some information of when and where it happened. Now, it seems to me that invariably locomotives in this country have the initials of the road and the serial number painted on the tender; and it seems a little singular to the writer that these should have been omitted. If you will explain this when convenient you will oblige

F. G. B.

TO THE EDITOR OF THE "SCIENTIFIC AMERICAN":

Do you not think that your accustomed sagacity had "gone wool-gathering" when you accepted the illustration of the remarkable railroad accident published in your SCIENTIFIC AMERICAN as a fact, or was it published as a sort of test on the powers of observation of your readers? You seem to think that the stock car on the left, standing on the track intact, would perhaps furnish a clue to the name of the railroad on which the accident occurred; while I am of the opinion that a car so close to an engine, sustaining a shock sufficient to have caused such an upheaval of two engines, would have been pretty badly demoralized. In fact, from what I have seen of railroad collisions, I do not think there would have been a piece of the car large enough for the number left of it. Another thing: the broken cylinder which you mention shows no part of the steam-chest, which on all ordinary engines is nearly as

large as the cylinder; and a photograph would surely show some corner of it projecting.

Another thing: I suppose I have seen several hundred locomotives and tenders, and I never yet saw one that did not have the name of the railroad painted on the side of the tender, or at least the initials of the name, than which no better clue could be obtained or wanted.

I think somebody has been deceived by a very cleverly executed drawing which has been photographed. And of course no one would dare to put the name of any railroad on a drawing of an imaginary collision. A. G. C.

TO THE EDITOR OF THE "SCIENTIFIC AMERICAN":

I notice a cut said to be taken from a photograph of a railroad collision, and asking your readers to tell where it occurred. In accordance with your request, I would say that it happened on the "Anywhere and Lunar Railway," and the photograph was taken by "Moonshine," as no locomotives are ever built on earth with such details of construction; and it is exceedingly improbable that earthly engines could get into such a shape without further damage to the stacks and other parts. C. A. W.

TO THE EDITOR OF THE "SCIENTIFIC AMERICAN":

I have been a reader of your paper for some time, and never thought, and do not think, you would print or represent an impossible thing, or that there was any "poppy-cock," so to speak, about your paper. The picture in which you represent railway engines colliding is impossible, and has the appearance of making a sensation, as being a profound secret of some railroad company, and a negative by hairbreadth adventure was secured—a kind of *New-York Weekly* sensation, of which I did not think you guilty. You have been imposed on in regard to its being a negative. We will take your paper as a map—top for north, bottom for south, etc. You will see the cylinder on left side of engine going east is represented in view, no steam-chest on it—the man who drew the imaginary cut forgot this important part of an engine. The left cylinder on engine going west is represented as cut smoother than plane and file could make the same; cast-iron don't break so smooth. The part of cylinder severed shows no bolts; no casting stub to bolt side-bars on. The stuffing-box around the piston is represented as small engines are made, but not as locomotive piston stuffing-boxes are made. The representation of the bell on engine going east does not hang as a bell would on an engine in the position this one is represented. The sketcher of this picture intended, but forgot, to put wires on the telegraph poles; and a road anxious to clear away a wreck and cover an accident would have wreckers and wrecking-tools at work before engines could cool off enough to take so peaceful a photograph as this one. With all these misrepresentations of a railway engine, I can't see how this can be a photographic picture, and think you have been imposed on, and should have seen these imperfections in the picture yourself.

A CONSTANT READER.

Without occupying further space we will observe, in conclusion, that we have received a number of letters from reliable correspondents, giving details of the accident as communicated to them by friends who visited the spot.

The accident took place on the morning of April 29th, 1874, on the Chicago and North-western Railway, a short distance east of the town of Franklin Grove, Ill. The names of the engines were the Lyons and the Lucifer. The colliding trains were freight trains. No person injured, as all the train men escaped by jumping. The remarkable embrace of the engines, as shown in our engraving, attracted hundreds to the spot. The photograph was taken by the employés of the photograph gallery of Mrs. E. E. Faunce, of Franklin Grove, Ill., near the scene of the accident, who sends us the following particulars, which any body may readily verify:

FRANKLIN GROVE, ILL., August 21, 1876.

TO THE EDITOR OF THE "SCIENTIFIC AMERICAN":

In reply to yours of the 16th inst., I will send you, towards the last of the week, five copies of the wreck picture, as we are printing to-day. The railroad company sent out to us to see what we would take for the negative, but they thought that the price was too high, so we still have the negative.

The accident happened at 4.15 A.M., on the 29th of April, 1874, and we took the negative between six and seven o'clock the same morning.

The engines were sitting on the end of the fire-boxes on top of the trucks; the bank and the ground that we were on would not let us take it any lower, and they stood in that way until 9.15 A.M. They fell over after they drew away the cars so as to remove the pressure that held the locomotives up.

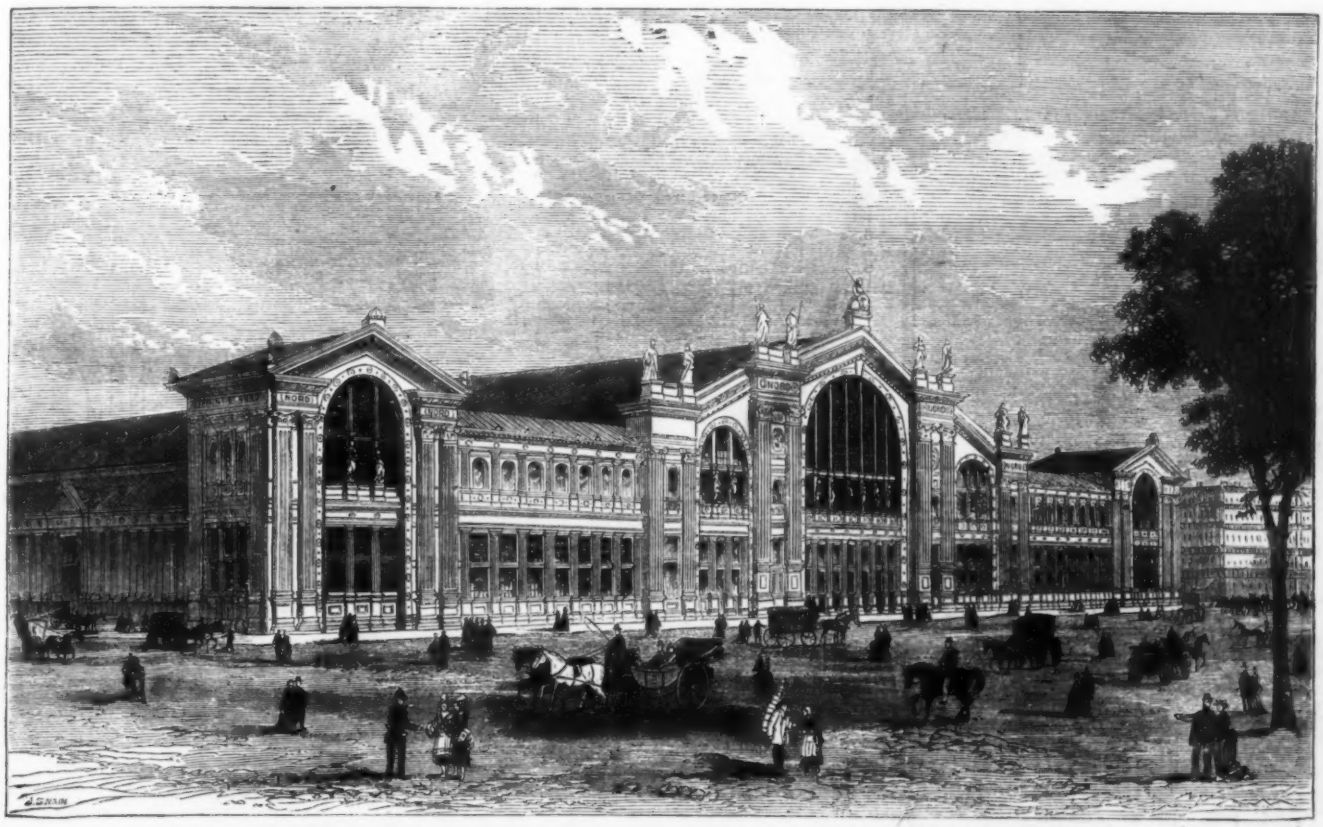
The engines' names were the Lyons and Lucifer, and they are on the road now, running by numbers. I do not remember the numbers.

The accident was caused by the conductor on the passenger-train, who carried a red light for a freight-train that was following him, but took it in on arriving at this place, and failed to notify the night watch and the conductor of the regular freight-train, whom he met here, and who was on his regular time.

The train going east was loaded, and the one west was empty. The trains met where the road was very nearly level, but there was a heavy grade west of where they collided, and also one east, towards this town. It occurred five eighths of a mile from this town, and I presume that there were 500 persons that visited the scene. This place is situated on the Chicago and North-Western Railroad.

What is singular is, that the steel rails, fastened with fish-plates, were not displaced. There were some ten cars that were pretty badly broken up, and especially one next to the engine; it was loaded with wheat. If you look at the picture you will see the initial letters of the road on one of the water-tanks. I guess that we have sold a thousand of the photographs, mostly to railroad men.

Yours, etc., MRS. E. E. FAUNCE.



THE PARIS TERMINUS, NORTHERN OF FRANCE RAILWAY.

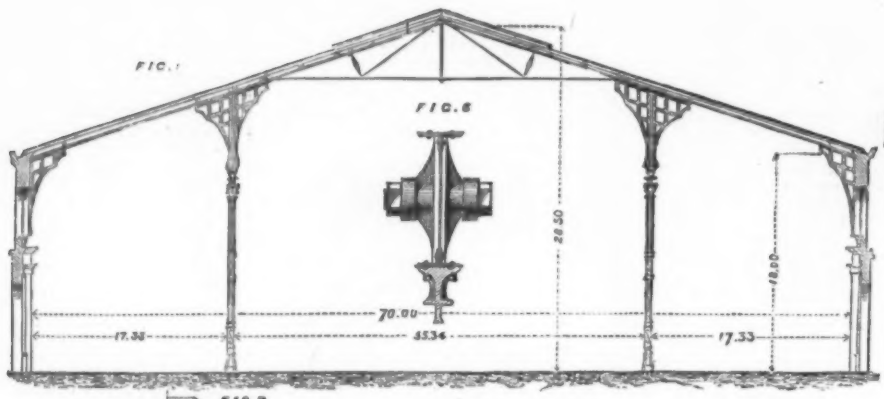
THE NORTHERN OF FRANCE RAILWAY TERMINUS AT PARIS.

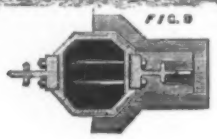
EVERY visitor to Paris has admired the noble façade of the terminus of the Chemin de Fer du Nord, situated in a commanding position at the top of the Boulevard de Denain, of which our perspective illustration will convey some, though an imperfect, idea; and those of architectural culture and taste will not fail to have remarked the skill with which the severe lines and level architraves of the Greek Doric, which is its prevailing style, have been blended and harmonized with the semicircular arched forms of a far later style, so as to adapt the building, structurally, to the uses of a modern railway station of the first order.

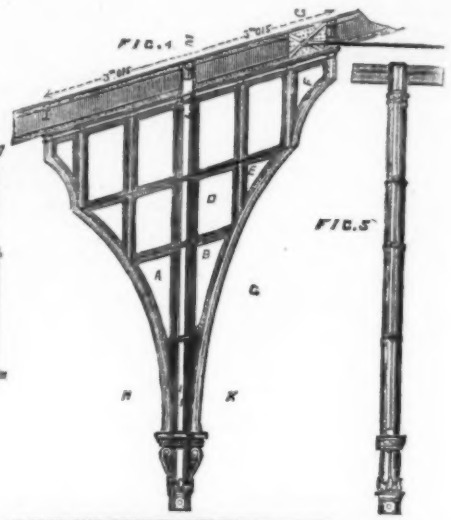
The great central hall for the arrival and departure of trains is covered in by a roof of great magnitude, and remarkable alike for the originality, simplicity, and beauty of its design. The design of this roof is due to the genius of M. H. Lejeune, as is also that of all other parts of the building. He is still the architect-in-chief to the Northern of France Railway Company. The whole station was completed in July, 1864. The area occupied by the entire station is about 9 statute acres, the area of the great hall alone being 3½ acres.

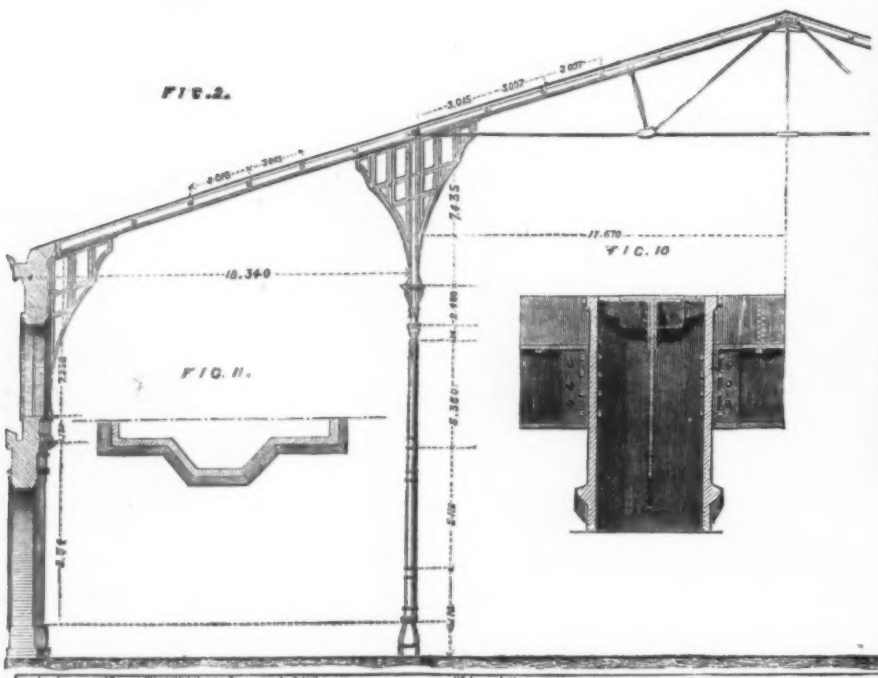
A general idea of the structure of this roof may be obtained from the transverse section, Fig. 1. The covering of the roof consists of two plane surfaces meeting each other at the ridge, and making a much smaller angle than usual with the horizon, namely, only about 18 deg., these surfaces consisting partly of glass and partly of 1½ in. grooved and rebated boarding, covered with Vieille Montagne sheet zinc, No. 14 in thickness, laid in sheets 2 metres by .8 metre with the usual methods for admitting of easy dilatation by increase of temperature. The entire span of the roof is nearly 230 ft., unbroken by any supports except two columns beneath each principal rafter. These columns are placed at about 57 ft. from the interior faces of the side walls, leaving a clear space between the two columns of 116 ft. The height of the side walls above the ground to the springing of the principal rafter is 59 ft., the height of the columns is 80.6 ft. to the under side of the principal rafters, and the extreme height beneath the ridge is 93.5 ft. The distance between adjacent principals and columns, taken the lengthway of the roof, is 32 ft. It will thus be seen that the general proportions of the structure are colossal, and from the great distance apart of the principal rafters and columns, the great length of the covered area—namely, 592 ft.—and the absence of any complicated web of tie-bars or struts, an appearance of almost fairy lightness is given to the structure, although the parts composing it are of huge dimensions. The offices and waiting-rooms placed within the façade, which constitute the termination of that end of the great hall, being only ten metres in height, their flat roofing forms a terrace, above which are visible from the inside of the main hall the monumental arches and architecture of the façade. The chief structural peculiarity in the design of the roof consists in the part assigned to the large openwork cast-iron brackets which surmount the columns and are firmly bolted to the lower webs of the principal rafters, and also in the nearly similar brackets built into the side walls and bolted in like manner to the principal rafters above them. It scarcely needs any prolix description to show that the effect of these brackets, each pair of which extends about 21 ft. along and beneath the principal rafter, is not only to prevent any transverse movement of the roof as a whole, or any spreading thereof between the columns without carrying the latter along with it, but also to prevent any flexure or sagging of the principal rafters themselves from taking place between the points of support. By means of these brackets, and of the strength given to the principal rafters themselves, the necessity is obviated for the interlaced web of struts and ties which deform the appearance from within of almost all great railway roofs, whether consisting of plane or of curvilinear covering surfaces. As no distortion of the roof itself can take place without producing flexure by a single or double curve in the columns themselves, it is apparent that the principle of greatest economy, namely, that all parts of the structure must yield before any one part can do so, is here well attained. The only tie-bars employed in this roof are limited to the space above the brackets which point towards each other in the central span, and, as will be seen by Figs. 1 and 17, consist of little more than a single and nearly straight transverse tie. In the two lateral bays, or between the walls and the ranges of columns, there are no tie-bars of any sort, the roof there consisting of the principal rafters only, together with the purlins which connect the same and support the covered boarding. The principal rafters are rather more than 26 in. in depth, and the conical and reeded parts of the columns are 1 ft. 7½ in. at top of the polygonal bases, and 1 ft. 4 in. in diameter below the brackets. The actual taper of these columns is thus seen to be small, but from the vast height of the shafts, their apparent diameter as they rise upwards is much diminished, so that in reality they have all the effect of the slenderness of Venetian masts, and charm the eye by the beauty of their proportion and the admirable style of ornamentation applied to them. It may be much doubted whether this optical effect due to great height would have been, if at all, as well allowed for by the mere structurally-educated engineer, as they have been here by the architecturally-educated experience of M. Lejeune. A central light at either side of the ridges reaches a width of about 65 ft., and is glazed with very large plates of thick glass, well secured into the surrounding iron mountings. This centre light or lantern is not continuous along the entire roof, being broken at intervals by boarded portions, which thus afford ready access from one side to the other of the roof. The details of its construction will be found in Figs. 30, 25, 26, 27, and 28. Besides the light here admitted, more perfect illumination is secured for the passenger platforms by very large Diocletian windows in the side walls, the horizontal diameter of these being 27½ ft., the width of the semicircular arches connecting

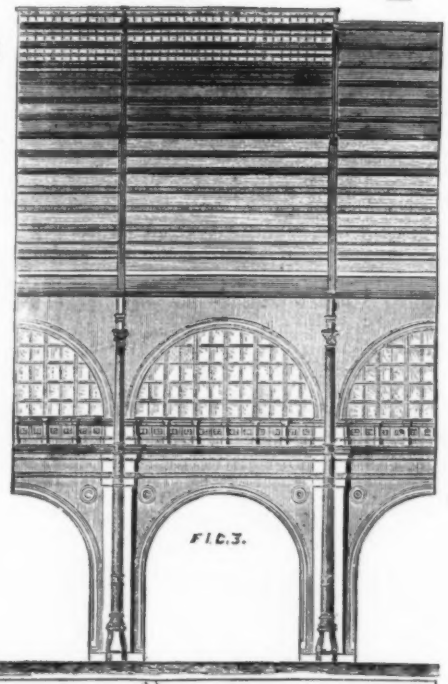
(Continued on page 634.)

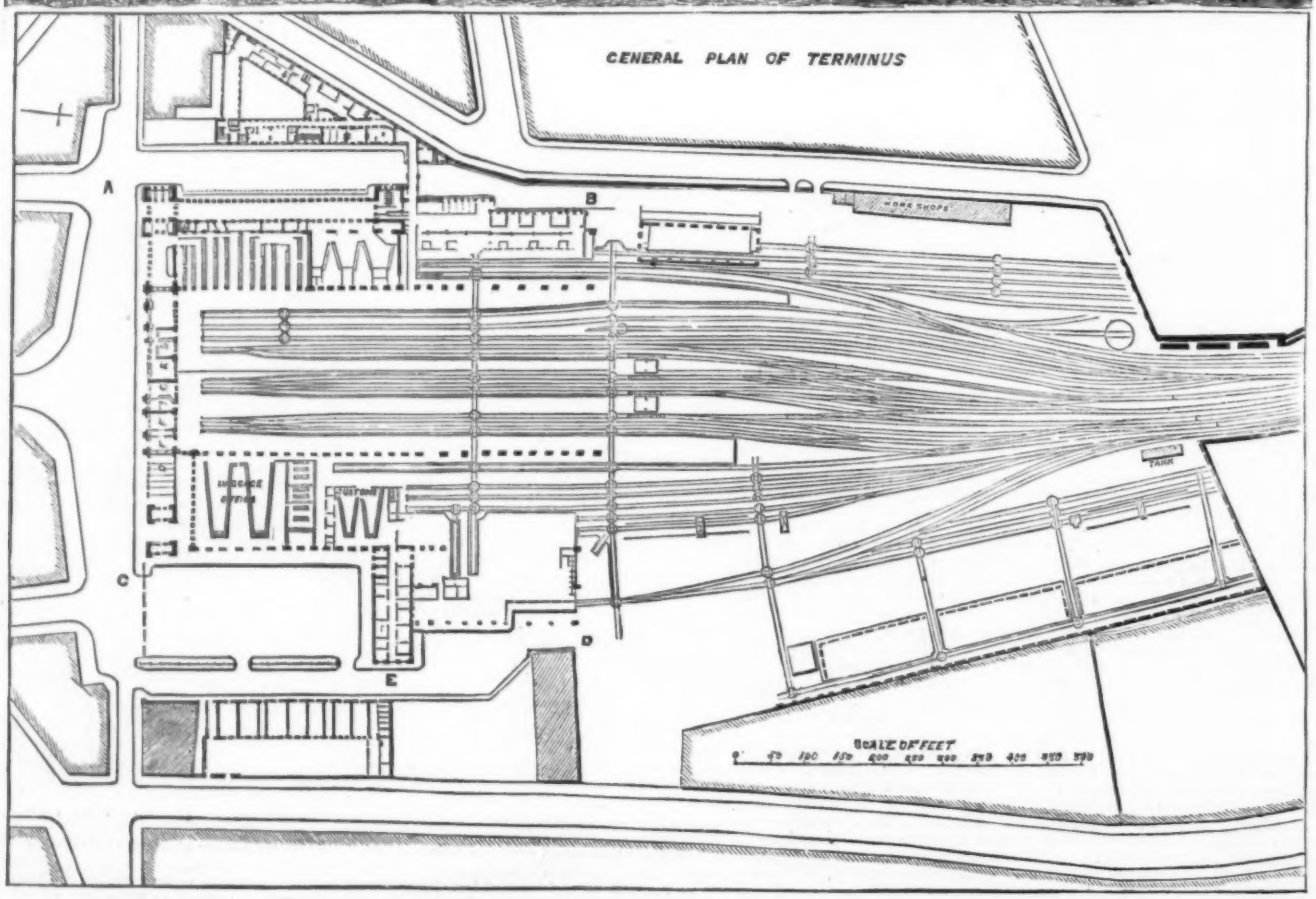




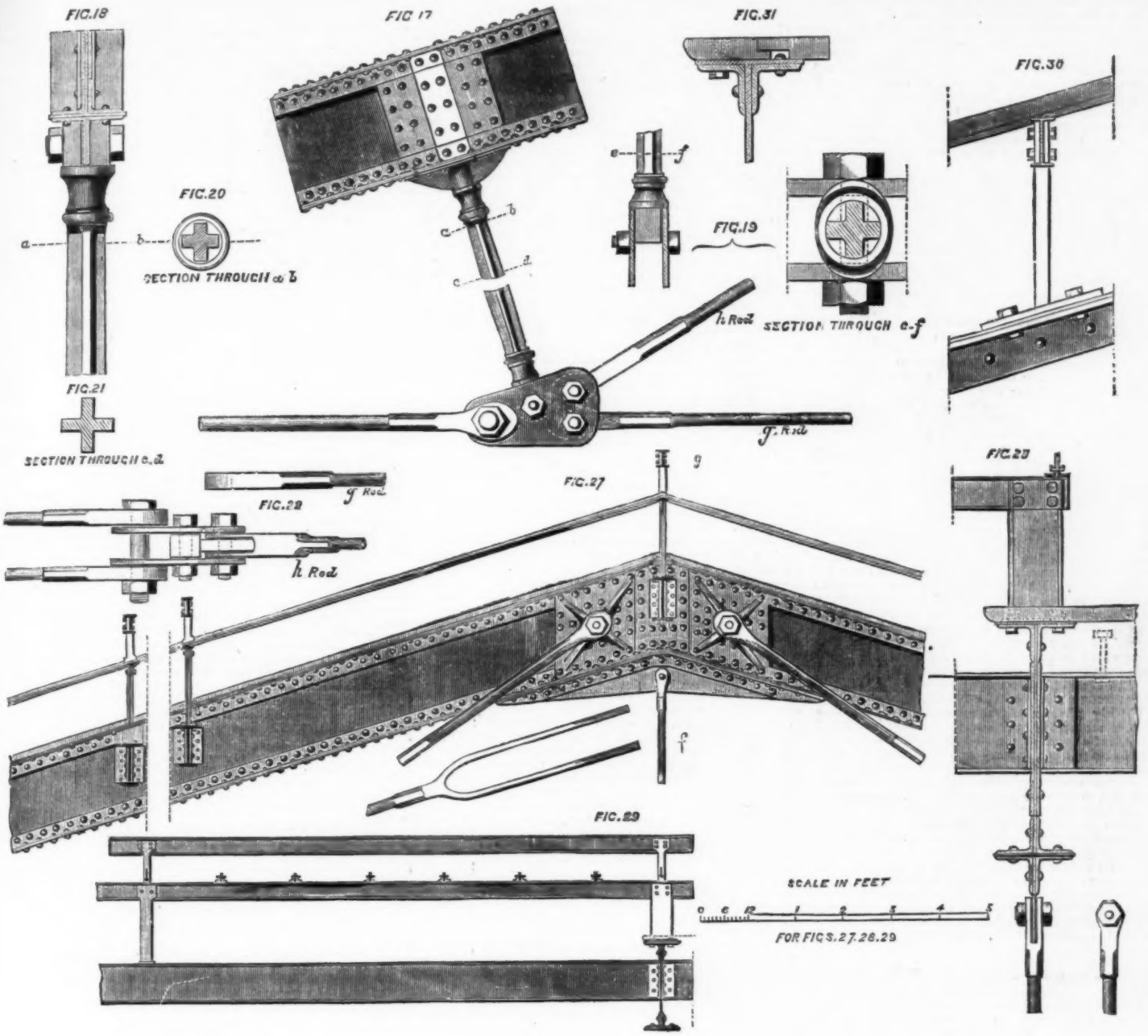


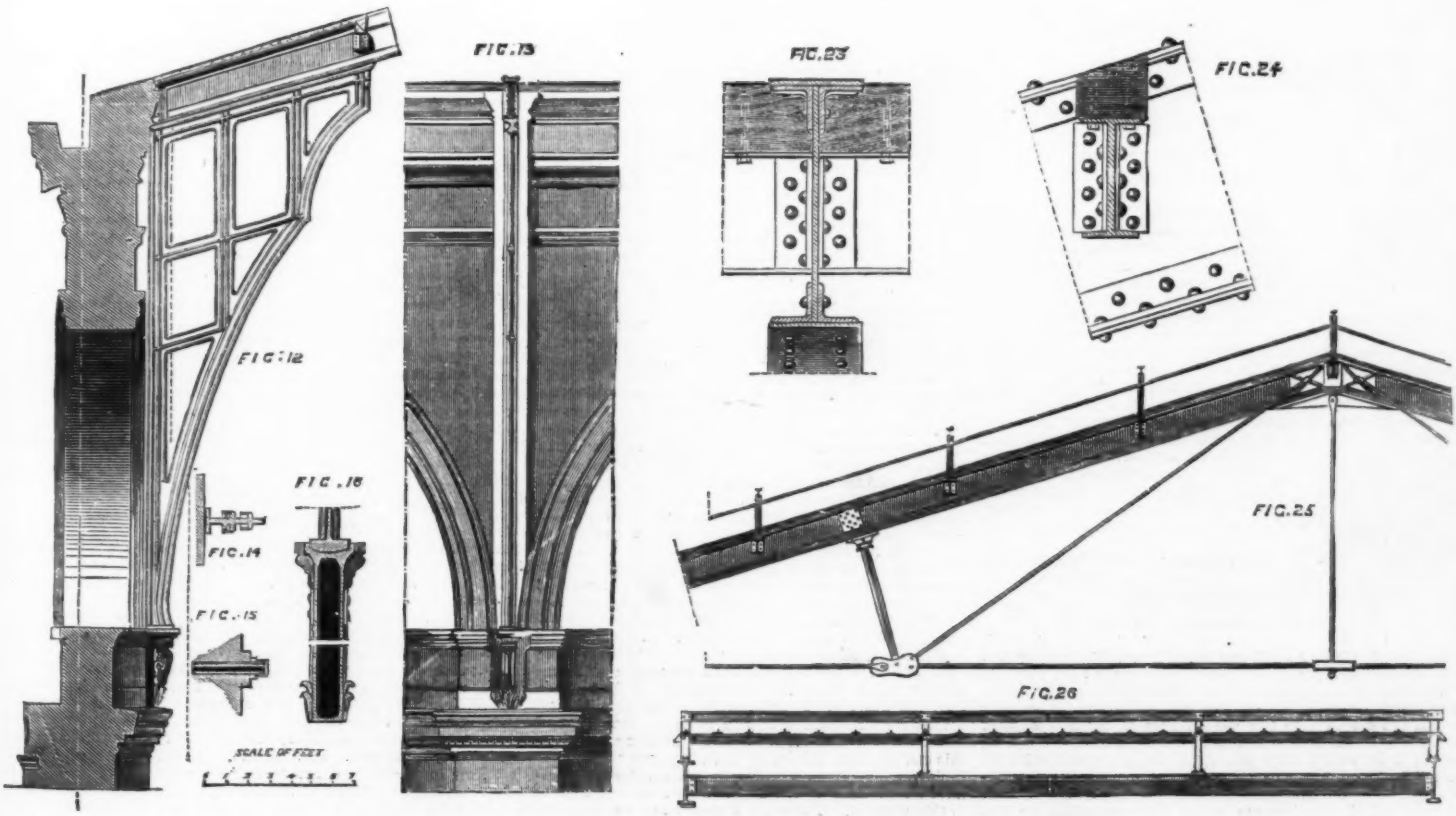






PARIS TERMINUS, NORTHERN OF FRANCE RAILWAY.





PARIS TERMINUS, NORTHERN OF FRANCE RAILWAY.

(Continued from page 631.)

this great hall with other parts of the building being 24 ft., as seen in the longitudinal section Fig. 3. The gutters over both side walls which take away the rain from this vast roof surface are formed in stone, and form part of the moulded exterior cornice which surrounds the building. The whole of the building being formed of a beautiful white tertiary limestone, and kept clean, produces an effect of light and liveliness, both exteriorly and interiorly, which contrasts very favorably with the dinginess of the bare brick interiors of several of our large English railway stations, deformed as they also are by the detestable custom of affixing staring panels of advertisements of all sizes and colors to their surfaces.

Having thus given a general idea of this roof, it remains to refer descriptively to the different figures which illustrate this article. Fig. 1, the general transverse section of entire roof and hall, has been already referred to. Fig. 2 is a transverse section of one half the roof, with the supporting columns, to an enlarged scale, showing the construction of the purlins which are double T-rolled joist iron about 10 in. deep, the connections of which, with the principal rafters, are shown also on Figs. 27 and 28, which also show the construction of the great brackets, further details of which are shown on Fig. 4. The purlins being firmly riveted at their ends to the principal rafters form continuous beams, and so the utmost duty possible is extracted from the iron they contain. Fig. 3 is a longitudinal section and internal elevation of the roof and hall, extending over parts of three bays or spaces between principal rafters; this shows well the effect of the Dioclesian side lights, and of the fine arched apertures beneath them. In Fig. 5 are shown in side and edge view the great brackets on the columns, and sections of the ribs or members constituting these brackets are shown in Figs. 6 to 11, the places of section being as follows: Fig. 6, section on F G, Fig. 4; Fig. 7, section on D E, Fig. 4; Fig. 8, section on A B C, Fig. 4; Fig. 9, section on H I J K, Fig. 4; Fig. 10, section on L M, Fig. 4; Fig. 11, section below K through the consoles upon which the brackets rest; Fig. 12, side elevation of a wall bracket, showing its connection with the principal rafter and insertion in the side walls above the capitals of the pilasters which project between the arched openings therein; Fig. 13, front edge view of same bracket, and front view of pilaster head upon which the bracket rests; Figs. 14 and 15 are sections normal to the framing of the bracket at the places opposite to which the sections are shown; Fig. 16 is a section through the console on which Fig. 12 rests, Fig. 16 being ½ real size; Fig. 17, details of main and secondary tie-bars and cast-iron struts belonging to the central span of the roof, as seen in Fig. 1; Fig. 18, head of cast strut, Fig. 17; Fig. 19, section through *e f*, Fig. 17; Fig. 20, section through *a b*, Fig. 17; Fig. 21, section through *c d*, Fig. 17; Fig 22, details of connection between tie-rods and bottom of strut; Fig. 23, section showing construction of principal rafter, and of junction of purlins with same; Fig. 24, section of purlin; Figs. 25 and 25, transverse and longitudinal section of lantern or skylight; ventilation is effected by a continuous opening between the roof covering and skylight glass, as seen in Fig. 25; Fig. 27, transverse section showing detail of construction of the ridge piece between the principal rafters and of the lantern or skylight; Fig. 28, transverse section through principal rafter and skylight at the central part of Fig. 28; Fig. 29, details of skylight as shown in longitudinal section, Fig. 3; Fig. 30, supporting struts and connections of sash-bars of skylight; Fig. 31, detail of jointing and connection of timber-cap battens on top surface of principal rafters. We believe the ventilation provided as shown in the above figures has been found insufficient, and probably will be increased if the lantern be reconstructed.

As regards the *ensemble* and functions of the respective parts of this noble roof, a crude prototype has no doubt long existed in the construction of the timber coverings of the largest class of graving docks and building slips in the naval arsenals both of France and England, as will be at once evident on inspection of the diagram Fig. 32. The eaves or

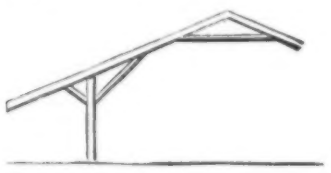


FIG. 32.

outer extremities of these roofs being most frequently cantilevers, as in the diagram, but sometimes sustained by rows of posts, whose main purpose was to admit of sliding weather-screens or shutters to exclude rain at pleasure. These facts, however, detract nothing from the merit of M. Lejeune's roof, which, carried out as it has been by him with consummate skill, presents in reality a new creation, and due, we believe, to himself alone, for we are not aware that there exists anywhere else in Europe a prototype of this roof in iron. As regards the elaboration of details, M. Lejeune acknowledges the collaboration of MM. Couch and Hittorf. The total cost of the entire station within the letters A B C D E on plan, and exclusive of stores, omnibus accommodation, etc., is reckoned at £300,000. The cost of the roof of the great central hall complete, including the columns but exclusive of surrounding walls or lights therein, or of any turn-tables, etc., and other such railway adjuncts, has proved to be £2 per square yard, which, although exceeding that of several English railway roofs, cannot be considered dear for a roof as elaborate and ornamental as this one.

We are indebted for the foregoing to *The Engineer*. In another article we shall give diagrams of a number of other forms of curvilinear roofs, with remarks.

BRITISH RAILROAD IRON has almost ceased to be imported into this country. In 1871 we took no less than 52¼ per cent of the total British exports, those exports being the largest ever made; in 1875 but 1¼ per cent of the much smaller British exports were to the United States. In 1871 we took 72 times as much British railroad iron as in 1875. What we took in 1871 would have laid 5,820 miles of track (with 56-lb. rails); the imports of 1875 were only enough for 79 miles of track. For the five years beginning with 1871 the mileage of track which the imports would have provided for was 5392, 5310, 2117, 128, and 79 miles respectively. The exports of Great Britain to the United States were nearly as great as (93¼ per cent of) its total exports to all countries in 1875.—*Railroad Gazette.*

THE GREENHOUSE AND GRAPERY.

BEST VARIETIES OF GRAPES.

FROM the time Noah began the culture of the grapevine, shortly after the flood, until the present time, different varieties of the vine—*Vitis vinifera*—have been continually making their appearance, and now they are enumerated by thousands, some of them as wine-grapes, others for table purposes. I intend giving in the following a short description of such kinds as are best adapted for culture under glass in this country; also a few of their synonyms:

Black Hamburgh.—This is the best-known grape in cultivation, and, without a doubt, one which possesses more good qualities than any other. It is vigorous in growth, very productive, and, when well ripened, one of the most deliciously-flavored grapes there is. It is seldom allowed to ripen so thoroughly as it ought, being often cut as soon as black; but it is not at its highest state of maturity until it just begins to shrink. The berries are large, round, and, when well grown, are covered with a very thick bloom. The bunches are large and shouldered. Its synonyms are Red Hamburgh, Valentine's Black, Portugal, Black Gibraltar, Frankendale, Hampton Court Vine, and a host of other names.

Victoria Hamburgh or *Frankenthal.*—This is a very strong-growing variety, being often seen under the name of Black Hamburgh, of which it is a seedling. The berries are, however, larger, not so well colored, and generally having a hammered appearance. The largest bunches I have raised in this country were of this variety.

Wilmot's Black Hamburgh.—This is also similar to the Black Hamburgh in appearance, but deficient in flavor and color, requiring a higher temperature and plenty of air to thoroughly ripen it. It is known also as Wilmot's Dutch Hamburgh.

Black Prince.—This is an excellent grape for keeping in good condition on the vines after it is ripe. The bunches are long and tapering, sometimes shouldered; the berries are oval, of a very superior flavor; the skin is thick. Unless thouroughly ripened, it has a rather acid flavor. It is a very productive bearer, and very suitable for the cold grapery. Its synonyms are B. Alicante, B. Lisbon, B. Spanish, Lombardy, B. Valentia.

Muscat Hamburgh.—If grafted on a B. Hamburgh stock, this is a very fine grape, but on its own roots is very tender and rather uncertain in setting its fruit. It is said to be a cross between the B. Hamburgh and Muscat of Alexandria, possessing, as it does, the rich, juicy properties of the one and the Muscat flavor of the other. It should not be kept long after it is ripe, as it loses, to a great extent, its fine flavor. The bunches are long, tapering, and shouldered, berries oval, large, and well colored. This grape should be grown in every collection.

Black Barbarossa.—This is a fair grape, producing very large bunches, with large oval berries. Its flavor is rather inferior, unless allowed to hang a good while after being ripe. A good many people in the States make a great mistake in planting this grape in a cold house, a place where it will not succeed, requiring, as it does, a long time to ripen, and a good, brisk heat to start it. Immense bunches from time to time have been raised of this variety, but it is not a suitable one for growing, unless in a large collection. Its synonym is Gros Guillaume.

Lady Downe's Seedling.—This is a fine grape for keeping a long time after it is ripe, and one of the best for a cool house. The bunches are long, sometimes shouldered, the berries round, and require to be well thinned to allow them to fully develop. It is a very difficult one to thin, being a great setter, and has very short fruit-stalks.

Black St. Peter's.—This one is another good keeping variety. The bunches are not very large, the berries round, having a fine bloom, and very rich in flavor; altogether a very desirable grape, and one to be recommended for general culture.

The above are all black grapes, and, although few in number, are just such kinds as are worth growing, when profitable and sure fruiting kinds are required. The following are a few of the best white and other colored varieties:

White Frontignan.—The prolificness and peculiar flavor of this grape are qualities which should entitle it to a place in every collection. It does best when "worked" on the Black Hamburgh. Upon its own roots it is sometimes very subject to shanking. The bunches are long, but never weigh very heavy; the berries are round, having a white skin. The synonyms are Raisin de Frontignan, White Constantia, Muscat Blanc, Muscat Beli.

Grizzly Frontignan.—This delicious grape, even more than the above, needs to be grafted on some strong-growing stock, as perhaps no grape in cultivation is more subject to insects and shanking, especially if grown on its own roots. The berries are of a pinkish color, round and small in size. The bunches are small and tapering.

Golden Champion.—This is a yellow grape of very delicious flavor, but of rather too delicate a constitution to be generally cultivated, being very apt to spot and decay before getting ripe. There are some who have succeeded very well with it. I saw a house of it at Dalkeith Palace—grown by Mr. Thompson, gardener at that time there—which was one of the finest sights in grape-growing I ever witnessed, the crop was so regularly distributed over the house, and the bunches and berries so equal. In general appearance this one, Golden Hamburgh, and the Duke of Buccleuch are very much alike, but differ very much in value and easy success in their culture. Golden Hamburgh is attempted to be grown by almost every grape-grower in the country, and seldom is it omitted when a selection is made and recommended for general culture, yet I do not think there is a worse grape to manage in general cultivation at the present day. It is without doubt a handsome grape when well grown, but very delicate in constitution, keeps only a short time after it ripens, and, taken altogether, a grape not at all to be recommended. The Duke of Buccleuch is one of the finest of the recently introduced varieties, being raised by the grower of Golden Champion. The bunches are large, the berries very large, and ripen very early, and, although great diversity of opinion exists about its merits, I look to a great future for it.

Muscat of Alexandria.—I think when well grown and thoroughly ripened this one has few superiors, if many equals, among yellow grapes. The bunches are large, shouldered, and make very attractive and noble-looking clusters. The berries are large and oval, and hang on the bunches rather loosely. Sometimes it is rather shy in setting fruit well, but this can be easily helped by brushing over the bunches when in flower. To ripen it well requires considerable heat, but I have seen some very good specimens grown in a cool grapery in this country. There are a great many seedlings from this one, some of which are classed quite distinct; but all the difference I could see between it and Bowood Muscat, Charlesworth Tokay, and several others, was the name. I do not think, if bunches of Muscat of Alexandria and Bowood Muscat were placed alongside of each other, any one could tell the difference.

Canon Hall Muscat.—Were it not that this is a very bad setting grape, it would be considered equal to the above in quality. It is a stronger grower, the berries are very much larger and rounder, and it is really a fine-looking grape, requiring considerable heat to mature it.

Royal Muscadine.—This is an old early variety, and one of the best white grapes for the cold grapery. The bunches are not very large, but sometimes shouldered; berries round, thin skinned, and very rich and sugary when ripe. It is often seen under the name of common Muscadine or Chasselas de Fontainebleau. It should be grown by every one. Foster's White Seedling is said to be a great improvement on this variety.

Raisin de Calabre.—This is a handsome yellow grape, suitable for the cold grapery and pot culture.

White Nice.—This is a variety producing very large bunches, but small berries—not a variety to be recommended.

Syrian.—This is another large grower, having large white berries. Some immense bunches have been raised, but it is not to be recommended.—M. MILTON, in *Country Gentleman.*

TWITCH GRASS.

I HAVE a grass upon my farm that I believe is common everywhere; and the more common, the more disliked. It is not a native of the country. It is said we owe it among us to the well-intended agricultural forethought of the government.

The larger growth is in the ground. The long, large, creeping roots freely branching are much jointed; and every joint, or I may say, every inch of the branches may send out a shoot. It is from these joints the bud that is to give leaf and seed starts. Carry the hoe to the garden, and cut up the roots by surface culture, and a multitude of individuals are given an independent existence. If I cut away a thousand plants and leave a hundred, these will soon become a thousand. It is something to know this, and it is more to act upon it.

I find the best way to be rid of this grass is the most thorough way, where it pays to fight it vigorously, as in a garden—upon the farm, where it competes with farm crops, a more prolonged fighting may be allowable. But whenever there is much of hand labor, we must rid ourselves speedily of this grass, and the thorough and efficient course to this is to make the land abundantly mellow, as deep as the roots extend, using such implements as will not break the roots, and then to fork out the plant root and blade, or pull them out by hand. Never break a twitch grass from the stem. Let the whole plant come out together, so that no fragment may be left to grow and again fill the soil. Go over the land a few times, and wherever a blade shows itself, extract the whole plant, and you conquer, or at least let me say I conquer when I will, and in no other way so cheaply. The time is best when the soil is dry, for then it is most light and mellow; and when the sun shines hot, so that the spread out plants quickly wither and lose their life. Then they need not be raked up and taken off at once, for their life is gone from them, and neither the damp day nor a summer shower succeeding will set them to growing. But cheapness there is none where twitch grass is. It is an expensive enemy to battle with, at best. I will note, however, a very cheap way of getting the grass distributed over the farm, and it is a way other kinds of grass, not desirable, can be increased. To save the purchase of seed to put upon bare spots, where the grass seems winter killed, sweep the barn floor until enough of seed is collected for the purpose. I have not done this; but from the distribution of the grass upon my farm at the time I came to it, I can but believe this economy had been practised. Now I think of it, there are many things I have not done, but they are not always such happy escapes from blunders.

THE REDWOOD.

THE redwood tree is a peculiarity of California forests. Oregon, in all her splendid groves, has none of it, nor can Nevada boast of a single one. The sombre shores of the great inland sea of Washington Territory are also without it, nor does Alaska boast a solitary sentinel of this family of gigantic evergreens. It belongs to the Golden State alone, and is a distinctive resource of her fast accumulating wealth. No other lumber splits so true to the grain, and none other can ever supplant it as perfectly in the uses to which it is now devoted. For fence-posts and railroad ties it is the most durable wood ever found, resisting the action of both air and water with unparalleled stability. Below San Francisco it is comparatively scarce, Santa Cruz and San Mateo being the only counties which have an average growth of it. And the rapid improvement of elegant farms in those counties is fast thinning out the towering forests. But on the north coast there is wealth enough to last for years, but the question is, How will these forests be replaced when they are thinned out by the insatiable demands of a growing commerce? In Japan every man who cuts down a tree must plant another in its stead; but no such stringent legislation prevails in this country. Sonoma, Mendocino, and Humboldt counties employ thousands of men, and are building up a substantial prosperity from their redwoods. Deserted logging camps are soon converted into dairy farms, and the once nomadic trampers who swung the axe in the silent woods settle down to grow up with the country advancing towards opulence.—*Northwestern Lumberman.*

HOW TO RAISE TURKEYS.

A FARMER'S wife, who has had years of experience, gives the following as her mode of raising turkeys: "In the first place, select a good kind. The autumn, or early in winter, is the most favorable time for that, just before the birds are sent to market. Keep them well during the winter. In the spring, just before they begin to lay, put them in an inclosure, where it is most convenient to have their nests, and where they can not get out. After they have made their nests, they may be set at liberty without any fear of roaming or straying. Next, take good care of the eggs. They should be gathered carefully every day and placed between layers of flannel or cotton, in a place of uniformly cool temperature, and turned over every day. As soon as the birds are hatched, feed them with warm bread and milk, well peppered, with boiled eggs added, or thickened with cooked corn meal, or wheat middlings, which is better. A little care in these matters will repay the efforts. Before I knew how to take care of the eggs, I set thirty eggs one year, and but one hatched. The next year I set forty eggs, and nearly all of them hatched and the birds lived."

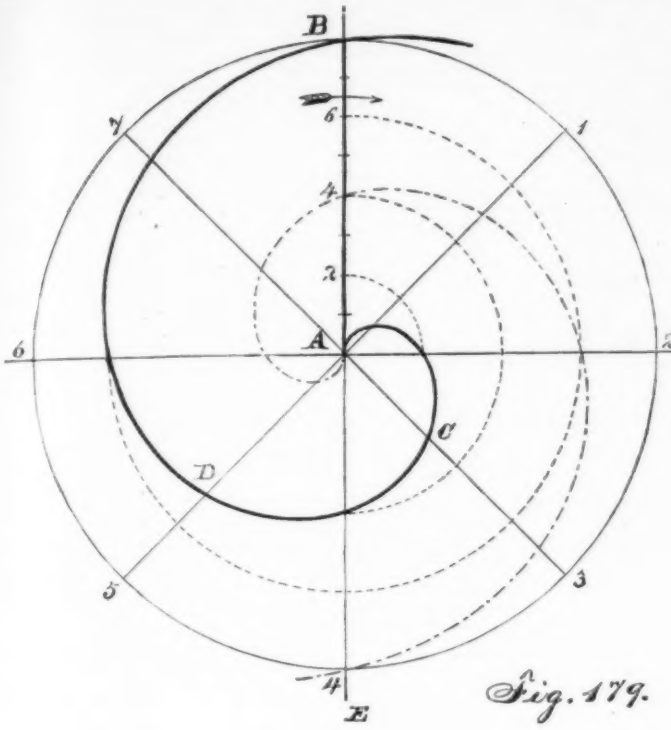


Fig. 179.

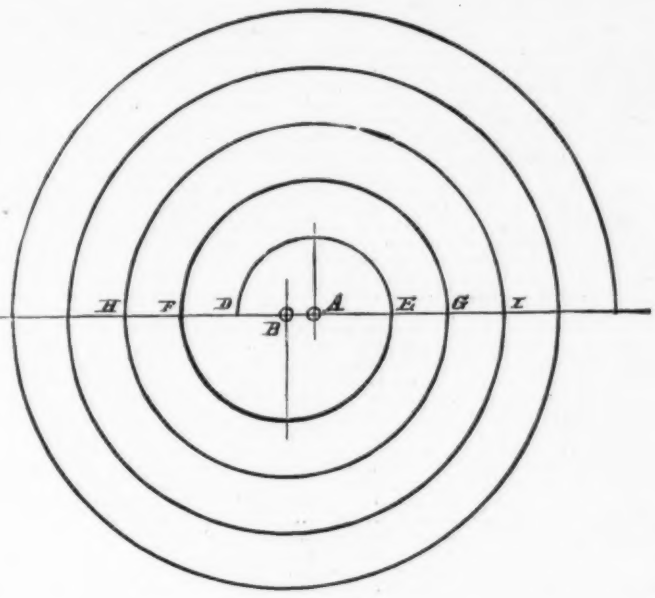


Fig. 180.

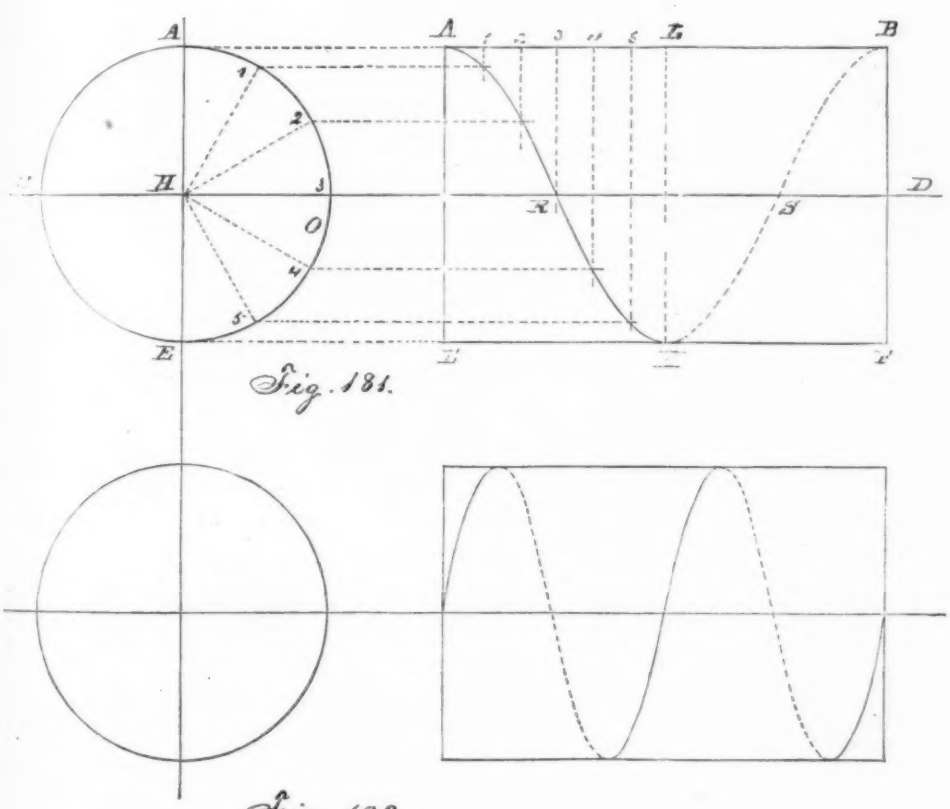


Fig. 181.

Fig. 182.

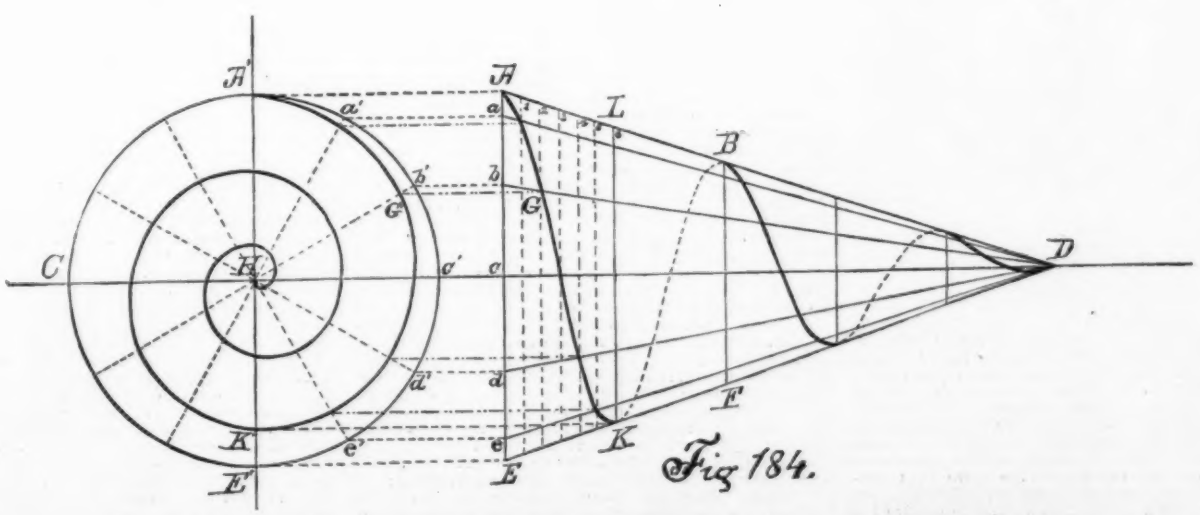


Fig 184.

Fig. 183.

LESSONS IN MECHANICAL DRAWING.

By PROF. C. W. MACCORD.

No. XXI.

(Continued from page 619.)

IT has already been remarked that in making drawings it is frequently necessary to construct curves by finding various points through which the lines must pass, and that consequently it is well to practise beforehand in laying out such curves. We have already met with one instance of this, in the drawing of the inclined cylinder, and as we are approaching a region in which we are likely to meet with many more, we introduce one or two other examples of work of this description.

The first is a spiral, which is a curve frequently met with in mechanical drawings. A good example is found in either the main-spring or the hair-spring of a watch, from which illustrations it will be seen that the spiral is, strictly speaking, a curve lying in one plane; though the term "spiral spring" is frequently, but incorrectly, applied in another way, of which we shall speak presently.

Now, considering the spring as made of a wire coiled round and round in a single plane, it will be readily seen that a great many different forms can be produced by winding the coils in various ways. For instance, the distance between two coils may be always the same, and yet we may make a great number of such springs, no two of which are alike, as this distance may be different in all. Or, again, the distance between two coils may in the same spring be different in different parts, so that an infinite variety of spirals may be made by following different laws of variation in this distance.

But for the purposes of drawing it is more convenient to consider the spiral as produced in another manner. Evidently in any case the coils become smaller and smaller, always approaching a central point; and it will easily be seen that if a pencil be arranged so that it can slide along a bar, while the bar itself turns on a pivot at one end, this double motion will result in the tracing of a line, whose form must depend on the rate of sliding compared with the rate of turning.

Thus, in Fig. 179, if the pencil be supposed to slide from A to B, it would merely trace the straight line A B if there were no rotation; if it were fixed at B, and then the line A B were to turn around A, a circle would be described; but if A B were to turn at the same time that the pencil travels along from A to B, we should have some kind of line different from either the circle or the radius.

Let us now suppose that the pencil starts from A in the direction A B at the same instant that the radius B A begins to turn around A, "with the clock," this direction of the rotation being indicated by the arrow.

Let us also suppose that the pencil travels from A to B while the radius makes one revolution about A, and that both the sliding of the pencil and the revolution of the arm take place at uniform rates. Then when the arm has turned through 90°, or a quarter of the revolution, the pencil will be one quarter of the distance A B from the centre A. In a half revolution of the arm the pencil will have gone half way from A to B, and so on.

Knowing this, we can now find as many points in the curve traced by the pencil as we may think necessary, in a very simple manner, thus: Describe a circle through B about A, and divide it into any number of equal parts at 1, 2, 3, etc. Also divide A B into the same number of equal parts, which are correspondingly numbered at 2, 4, 6. Then through the points of division on this radius describe circles intersecting the radii drawn through the corresponding points of division on the circle, and these intersections will be points in the required curve. In the figure we have dotted these circles only through the alternate points, which is sufficient to illustrate the mode of construction. And that is all that this diagram is intended to do; in practice it is of course wholly unnecessary to *draw* these circles, it being sufficient to mark the intersections, and as many more points may be determined as may be desired, and the number needed will depend altogether on the curvature of the spiral, which, as already stated, will vary according to the conditions assumed.

We have shown only one coil, but as many more may be drawn as circumstances require, it being clear, on the assumption that the radial and the circular motions are both uniform, that in making each revolution the pencil will travel outwardly along the revolving arm through a distance equal to A B.

The central point A is called the *pole*, and the varying distance from the pole to any point in the curve, as A C or A D, is called a *radiant*.

The particular spiral here shown is called the *equable* spiral from the uniformity of the two motions of the point by which it is traced, or more commonly, perhaps, the Spiral of Archimedes, from its discoverer.

This curve passes through the pole, which is not the case in all spirals; and in drawing it particular attention should be paid to the circumstance that A B is tangent to the spiral at A.

We may imagine the arm A B to be extended across the pole, and the pencil to move in the opposite direction—that is, from A toward E; but if the revolution be in the same direction as before, this will result only in describing a spiral precisely like the other, but passing through the point in the circle diametrically opposite to B, as shown. These spirals then are both right-handed; but a left-handed one may be drawn in a manner precisely similar to that above explained, the only difference being that the revolution must be reversed, the arm turning "against the clock" instead of *with* it.

This is the mode of construction when it is necessary to draw a true spiral; no part of which, it is to be observed, is actually circular, since the length of the radiant is always changing. But for a great many purposes an accurate representation is not at all necessary; something that resembles the true curve is all that is required, for instance, in showing the arrangement of the mechanism of a watch or spring clock. To be sure, the actual spring when made and put in place might be a perfect Archimedean spiral, but for illustrative purposes it would not matter in the least whether it were or not, and all that is needed is an indication of the existence of a coiled spring with a reasonable degree of approximation to the actual form.

In Fig. 180 is shown an exceedingly simple way of drawing, what in nine cases out of ten will for such purposes answer as well as the more laborious accurate curve of Fig. 179. On the indefinite line H I two centres, A and B, are taken; about A describe the semicircle D E, then about B draw the semicircle E F; next, with A as centre, draw the semicircle F G, and so on. The distances D F, E G between successive coils are each evidently equal to twice the distance A B between the assumed centres, and the curve thus composed of a series of tangent semicircles, if the junctions are carefully made, will look enough like a spiral to deceive the very elect.

We remarked above that the name "spiral spring" is very often misapplied. It is so, in this way: if we wind a wire round a rod, more or less closely as the case may be, and then slip the rod out, we have our wire coiled up into a form to which the name mentioned has been applied so often and so long that the error will probably never be corrected, in the common speech of even those who make and use these things, which are, and of right ought to be called, *helical* springs. The distinction in point of fact is well enough marked, as the illustration just given shows that the helical spring is not coiled in one plane, while the spiral one, properly so-called, is.

The curve called the helix is one which will be met with very often in making mechanical drawings; it is the form of the common screw-thread, or at least of the boundary lines of the thread, and indeed has so many applications in mechanical details that it is important to be able to construct it accurately under different conditions; for which reason, as well as to illustrate the difference between its representation and that of the spiral, we introduce it here in its elementary form as an exercise. We have spoken of it in the concrete as formed by winding a wire on a rod, meaning of course a cylindrical rod. If the wire be very fine and evenly wound, this illustration will give a good idea of what is known as the *true helix*.

Otherwise: let A B F E, Fig. 181, be a side view, and the circle whose centre is H be an end view of a cylinder. If now a marking point be placed at A, and moved along in a direction parallel to the axis C D, it will trace on the cylinder merely the right line or element of the cylinder A B. If, on the other hand, it be moved round the cylinder without advancing in a direction parallel to the axis, it will trace simply the circle seen in the end view, which in the side view is represented by the line A E. But if it be given both motions, so as not only to travel round the cylinder, but to move endlong at the same time, the result will be a line different from either of those mentioned, of which the nature will depend on the laws of the two motions.

In describing the true helix the marking point has a uniform rotation, combined with a uniform linear advance—that is to say, it moves round the cylinder—say in the direction of the arrow—at a uniform rate, and at the same time moves with uniform speed in a direction parallel to the axis. There is no connection between the velocity of rotation and the velocity of the advance: the latter may be small or great, and we may choose for ourselves what it shall be. But since both the motions are uniform, the most convenient way to give a clear idea of the speed in one direction as compared with that in the other, is to state how far the point moves endlong while going once round the cylinder.

For illustration, then, we will assume that, in going once round the cylinder in the direction indicated by the arrow, the marking point moves in the direction of the axis, to a distance equal to A B. Both motions being uniform, in going half way round it will travel half that distance, in going a quarter of the circumference it will go one quarter as far endlong, and so on.

Bisect A B in L, and draw L K perpendicular to the axis: then, at the end of a half revolution, the marking point starting at A will be found at K. Divide A L into any number of equal parts at 1, 2, 3, etc., and the semi-circumference A O E into the same number of equal parts at the points correspondingly numbered. Then in going round the cylinder through one of these divisions, the marking point must have travelled endlong through one of the divisions in the side view; consequently, we draw through the points 1, 2, 3, etc., on A L, parallels to A E, and project the points 1, 2, 3, etc., on the circle, into the parallels correspondingly numbered, as shown by the dotted guiding lines, which are of course parallel to the axis, C D. Through the points on these parallels thus determined draw a curve, which will be the side view of half the coil of the helix, as A R K in the figure.

The marking point still progressing, disappears behind the cylinder, tracing there the other half, K B, of this coil, which is dotted because it is out of sight if we suppose the cylinder to be opaque. We have given no indication of the construction of K B, because it is perfectly clear that it will be precisely similar to K A, only in a reversed position.

Now, in regard to the portion A R K itself, it is to be observed that it also is made up of two equal and similar curves in opposite positions: thus A R is precisely like R K, and would exactly coincide with the latter if swung around R as a pivot until A came to K. In so far, then, as the actual determination of the curve is concerned, it is only necessary to construct the branch A R, from which R K, K S, and S B may be copied by transferring, as previously explained.

The curve thus drawn has certain peculiarities of form, no matter what the proportions are, attention to which is necessary in order to avoid unpleasant effects resulting from even slight inaccuracies in those parts most affected by these peculiarities. The branch A R, it is to be particularly noted, is concave on the left, and its curvature is greatest at A, continually diminishing toward R, which is a point of contrary flexure; that is to say, the branch R K is concave on the *right*, and its curvature, because this branch is similar to the other, increases from R to K; the direction of the curvature therefore changes at R.

And in drawing this curve, especial care must be taken at the vertices, A, K, B, which should be tangent to the outlines of the cylinder, A B, E F; this circumstance is very frequently neglected, even in drawings making considerable pretensions to accuracy, and the effect is hideous. Moreover, it follows from what has been said that the portion R K S, and indeed we may say truly the whole coil A K B, is symmetrical about the line L K; any defect in this respect will, however, be more conspicuous in the region of the vertex, K, and before inking in the curve it should be carefully studied with an eye on the alert to detect any such fault.

No portion of this curve is in fact an arc of a circle, but as in all other cases, it is perfectly safe as a practical rule to assume that if a centre and radius can be found, with which a circular arc can be drawn coinciding so nearly with the actual line that the eye can not detect the difference when both it and the arc are drawn in the finest and sharpest pencil lines, one may be substituted for the other. And in this particular case the student is advised invariably to draw the parts near the vertices, as at A, K, and B, with the compasses or spring-bow, according to the size of the drawing; the centres will of course lie on the lines A E, L K, B F, and their locations and the radii may be found with all needful precision by trial and error.

The distance A B, measuring the travel in the direction of the axis during one revolution, is called the *pitch* of the helix. This, as already remarked, is entirely arbitrary, and so is the diameter of the cylinder; and by varying these conditions this curve may be given an infinite variety of forms.

We have imagined the cylinder to remain at rest, while the marking point moves around and along the surface; but it will at once be seen that the same curve would be traced, if we suppose the marking point to travel along from A to B, while the cylinder turns once round, in the direction opposite to that shown by the arrow. This, our mechanical readers need not be told, is exactly what is done in the screw-cutting lathe, the pitch of the screw being varied by adjusting the "feed" or rate of aërial advance.

It will be noticed also that the helix in the figure is right-handed; and it need hardly be added that the drawing of a left-handed one is made in a manner precisely similar, with the one exception that the direction of the revolution is reversed; in Fig. 182 is shown one of the latter description, the pitch being but half that of the other; but the construction lines are omitted as being unnecessary.

In drawing the spirals, or other plane curves, as exercises, there is no objection to making them in heavy lines, as in Figs. 179 and 180. In the case of the helix, however, this is not so. The reason is that the curve does not, like the spiral, lie in one plane, and in order to give the idea of solidity, there is no expedient so good as the representation of the cylinder on which the helix lies, as a solid and opaque body. And the outlines of this cylinder should not be thick and heavy, as, if they are, the whole drawing will appear coarse and careless; and the curve being tangent to the outlines, ought not to be made any heavier than they are.

We do not mean to say that the cylinder *can not* be omitted, for it certainly can be, and the helix drawn by itself; but if it be a mere line, as we have supposed, the effect of relief will be lost, and the helix will appear merely as a sinuous plane curve, as shown in Fig. 183.

Inasmuch as this is a curve with which we shall have much to do, in the representation of screws of various kinds, the student is advised to give especial attention to it, and to practise by drawing it on various scales, with different pitches, and both right-handed and left-handed, until he is not only thoroughly familiar with the details of the construction, but able to draw it under any conditions with certainty as to the smoothness and regularity of the line, its symmetry in relation to such lines as L K in Fig. 181, and its tangency to the outlines of the cylinder.

What is called a *conical* helix is drawn on the surface of a cone instead of that of a cylinder. This is represented in Fig. 184; the marking point starting say at A, goes not only *round* the cone, but at the same time travels, not in a direction parallel to the axis, but in a right line toward the vertex. Or if we suppose the cone to revolve on its axis, and the marking point simply to move in a right line from A toward D, the same effect will be produced as in the case of the cylinder.

Now, if we imagine the motions to be uniform, as in the preceding case, the method of drawing the curve will be apparent. Bisecting A B, and drawing L K perpendicular to C D, the marking point at the end of half a revolution must be at K in the side view, which corresponds to K′ in the plan or end view.

Subdividing the base of the cone into equal parts at *a*′, *b*′, *c*′, etc., these points appear in the other view at *a*, *b*, *c*, and the elements of the cone as the lines *a* D, *b* D, etc., which in the end view are the radii *a*′ H, *b*′ H, etc. A L is also divided into as many equal parts as there are divisions in the semi-circumference A′ C E′, and a series of parallels to A E drawn through the points of division, 1, 2, 3, etc.

Then, suppose the marking point to have moved round the cone through an angle A′ H *b*′, measured by two of these divisions; it must also have moved from A toward the apex D, through a distance measured by two of the divisions of A L, and is therefore to be found somewhere on the parallel to A E, drawn through the point 2. It is also somewhere on the element of the cone which appears in the end view as the radius *b*′ H, and in the other view as the line *b* D. In the side view, then, the marking point must at that instant be at G, which corresponds to G′ in the end view. And in a similar manner we may find as many other points as we please, through which the curve is to be traced in the usual way.

As in the common or cylindrical helix, this curve in the side view is tangent to the outlines of the surface on which it is drawn. But it is not, like that one, composed of similar and equal branches; A K, for instance, is not like K B, nor is the first half of either of these parts like the second; this arises from the circumstance that while the linear advance toward the apex of the cone is uniform, the diameter of the cone is continually decreasing.

And for the same reason, the whole surface of the cone is visible when viewed from a point above the apex, and consequently the whole of the curve can be seen, and must, therefore be drawn, as in the end view in the diagram.

Since the motion from A toward D is uniform, and A D appears in the end view as the radius A H, and the angular motion round the centre H is also uniform, it is evident that the conical helix will appear in the end view as a true spiral of Archimedes, like Fig. 179; the distance between the coils will of course vary with the pitch of the helix and the inclination of the sides of the cone to the axis.

Springs are frequently made in this form for various purposes; in representing them the thickness of the wire of which they are made will naturally modify the appearance of the drawing; this is equally true of the more common form of the true cylindrical helix as well; all which will be more fully explained in due time.

For the present the student is advised, as in other matters, to make himself master of the principles, and to practise the drawing of the curves by themselves as mere exercises; it certainly is no more difficult to draw one helix than it is to draw two or more, and that is substantially what the practical application of this in representing screws and springs amounts to.

DR. KÖNIG has succeeded in photographing sound, or rather the vibrations causing sound. In the supply-pipe of a burning gas-flame he has an opening closed by an elastic membrane, and if any one speaks or sings, or a tuning-fork is held against the membrane, its motion is transmitted to the gas-flame. A mirror, drawn along by clockwork, reflects the image of the flame, which is seen as a curve whose form varies with the pitch of the sound. This curve of light has been photographed. Dr. Vogel suggests cyanogen as a gas giving a powerful actinic light.

THE *Wollengewerbe* announces that in a communication addressed to them by Messrs. Hans Ewald & Co., in Zittau, the latter claim to have discovered a new spinning fibre—as a substitute for cotton—which is not merely 20-25 per cent cheaper than cotton, but also having the further advantage of being more woolly, stronger, and better. It is of Continental growth, and abounds *en masse*, being also procurable from the above-mentioned firm. Messrs. Ewald & Co. are prepared to send samples and prices to any so-minded party, and the *Wollengewerbe* adds that from the cotton, and the "new substitute samples" which have been submitted to their notice, they must decidedly give preference to the latter.

NOTES ON ENGLISH CHEMICAL MANUFACTURES.

By S. CABOT, JR.

To give an account of the chemical advance, even during a few years, in a great country like England, is no easy task, if only in a sketchy and superficial manner. Nevertheless, having had very good opportunities of seeing some of the newest processes in use in England and Scotland, I propose to run through my note-books for the benefit of your readers, leaving out many particulars which would not be interesting to any but specialists, and many which are parallel to our American methods.

MANUFACTURE OF SULPHURIC ACID.

Sulphuric acid seems to be the starting point of almost all the larger chemical industries, therefore we will begin with that. The pure acid is made exclusively from sulphur. In the best chemical works (for instance, Mr. Riley's of Accrington, near Manchester), the sulphur is supplied through a hopper at the top of the furnace, the nitre and strong nitrous vitriol being also let into a cast-iron pan in the exit flue by means of another hopper.

The nitrous fumes are removed from the chamber gases, at the end of the set of chambers, by the use of a Gay-Lussac tower. Vastly the larger portion of the sulphuric acid made in England is, however, obtained by the combustion of pyrites. In addition to the much smaller first cost of sulphur thus obtained, it is in this case possible to use the Glover's towers, which cause a great saving in fuel. The principle of the Glover's tower is well known, but I will describe them as I saw several in England. They are towers made of acid-proof stone joined together by grooving the edge and then inserting a rubber rod; at the corners these rods are slit, and one is run through the other. The whole is bolted together outside with iron rods. These towers are from 30 to 40 or 50 feet high, and are filled with some acid-proof brick. At the top are two tanks, one containing chamber-acid, and the other nitrous vitriol from the Gay-Lussac tower. These acids are allowed to flow together down through the tower, while the hot sulphurous acid from the pyrites burners rises up in the opposite direction and carrying some water as steam, and much nitrous acid goes forward into the chambers. Many attempts have been made to use the Glover's tower where sulphur was burned. The reason of failure is that, as Professor Kopp once told the writer, sulphur can never be raised to the temperature obtained by burning pyrites, as it is volatile at a much lower temperature. The acid as it comes out of the towers is not far from 55° or 60° Bé., and may be concentrated in glass or platinum stills as is done in this country.

THE LEBLANC SODA PROCESS.

The greater part by far of this acid is, however, used for the decomposition of salt in the Leblanc soda process.

This decomposition of salt is done in hemispherical cast-iron pans, which are connected with absorbing towers constructed much like the Glover's towers, but filled with coke. These pans are separated by a sliding door with a muffle furnace, into which the mass is shoved while still quite liquid, and this muffle is connected with another condensing tower in which a less pure hydrochloric acid is obtained.

There is, however, a new method of accomplishing the decomposition of salt, patented by Hargreaves & Robinson. The process is, briefly, to pass a mixture of air, sulphurous acid, and steam, through salt in a porous condition, obtained by moistening it and then drying and breaking it up to the required size. This has the obvious advantage of doing away with the sulphuric acid chambers entirely.

The operation is performed in immense cast-iron chests heated on the outside with coal fires, and the gas from pyrites burners is put in at the bottom of one with an excess of air and some steam; it is then taken in at the top of a second one, and so on; this is, of course, changed about as one after the other of the chests is discharged.

The hydrochloric acid is very strong; indeed Mr. Hargreaves told me, in showing me the condensing apparatus, that in the first pipes it was stronger than by the ordinary method.

The sulphate of soda formed seems to be of good quality, and manufacturers are looking with much interest to see the result obtained by several large establishments running on this plan.

The salt in its porous condition is thought to act catalytically, causing the sulphurous acid (SO_2) and oxygen from the air to form (SO_3), which, however, would not occur without the presence of steam to form (H_2SO_4) sulphuric acid, which in turn reacts on the salt to form (Na_2SO_4) sulphate of soda and (2HCl) hydrochloric acid.

In the preceding paragraphs I disposed, rather summarily perhaps, of the various methods of manufacturing sulphate of soda and muriatic acid. I now propose to take up the various products of the latter acid and give a sketchy account of the methods in use in England for the manufacture of chlorine and chloride of lime.

CHLORINE BY WELDON'S PROCESS.

The two prominent, almost universal, methods of producing chlorine are by the Weldon and the Deacon processes. The Weldon process is properly only a method of regenerating the oxide of manganese from the chloride of manganese, formed by the action of the muriatic acid on natural binoxide of manganese.

By far the larger portion of the chlorine manufactured in England is produced under Weldon's patent, 101,600,000 kilograms, or over two hundred million pounds of chloride of lime, having been put on the market during the year 1874 to 1875 in England alone.

I had the good fortune to make the acquaintance of Mr. Weldon, and with him made an excursion of a day to some of the large works at St. Helen's, near Manchester, in one of which I saw his process in operation to great advantage.

The native binoxide of manganese is decomposed in large sandstone chests with muriatic acid; to assist the operation steam is introduced through a small (earthenware) pipe. The chloride of manganese is run into a large stone reservoir while still hot. Here it is treated with a sufficient quantity of finely powdered limestone to neutralize all excess of acid; this throws down any iron that is present as the carbonate of the peroxide. The clear liquor is then pumped up into tanks where it is mixed with an excess of hydrate of lime. It is then warmed to 55° or 75° Cent., and then a powerful blast of air is blown through pipes which open in fine jets at the bottom. The protoxide of manganese is hereby oxidized to the binoxide which unites with the lime to a feebly combined acid manganite of the composition, $CaMnO_3H_2MnO_3$, or $Ca\left\{\begin{matrix}H_2\\ \\ \end{matrix}\right\}(MnO_3)_2$. This compound is a brownish black paste which sinks to the bottom while a clear solution of calcic chloride remains above it. This calcium chloride is sometimes treated with sulphuric acid to obtain precipitated calcic sulphate (Paris white) for papermakers, etc. The sediment of bi-manganite of lime is run direct into the chests of sandstone in which it is treated with its equivalent quantity of muriatic acid. It is, however, in a state of exceedingly fine division, and therefore requires less heat to produce the reaction. The calcium of the compound (bi-manganite of lime) requires, however, two equivalents of muriatic acid, lost in the chloride of calcium, which is usually run away for the benefit of the fishes.

$$CaOH_2O(MnO_2)_2+14HCl=CaCl_2+2MnCl_2+8H_2O+8Cl.$$

It is evident from examining the above formula that not only two equivalents of muriatic acid are lost on the calcium, but four more are lost on the chloride of manganese (afterwards changed to chloride of calcium by the addition of lime). In an attempt to avoid these losses Mr. Weldon has invented and patented another process, which I will only briefly notice, as it has not as yet proved a success in a commercial sense, I believe.

In place of lime in the regeneration of the chloride of manganese, he proposes magnesia (MgO). The solution of $MgCl_2$ (chloride of magnesium) with suspended bi-manganite of magnesia, is evaporated. As it approaches dryness muriatic acid is given off, which is condensed for further use; then a stream of air is let in and the mass is roasted in a muffle, whereupon the manganite of magnesia reacts on the chloride of magnesia and gives chlorine (mixed with air). After roasting with an excess of air, the mass becomes changed to manganite of magnesia. This is treated with aqueous muriatic acid, whereby chlorine and a mixture of chlorides of manganese and magnesia are produced, which latter mixture is treated as before. Theoretically this process is subject to no loss of chlorine, but there are many practically important obstacles to its success—the difficulty of evaporating chloride of magnesium without destroying the vessel containing it, etc. Both of Weldon's processes are at a glance nothing but indirect methods of decomposing hydrochloric acid by means of the oxygen of the air. We now come to a direct method of accomplishing the same result. This we see exemplified in Deacon's chlorine process.

DEACON'S CHLORINE PROCESS.

This process I had the good fortune to see in Deacon's own works. It depends upon the decomposition of hydrochloric acid at high temperatures by the oxygen of the air in the presence of a salt of copper. The gas from the converting furnaces mixed with air is passed through chambers heated outside to between 400° to 500° Cent., and filled with earthenware balls moistened with a solution of sulphate of copper. The mixture is decomposed according to the following reaction:

$$\underset{\text{air.}}{\underbrace{N+O}}+2\,HCl=H_2O+Cl+N.$$

The mixture of nitrogen, chlorine, and steam, is cooled, whereby the steam is condensed, then washed with water to remove any excess of acid which has not been decomposed, and then passed into the lime-chambers, which must have a large surface on account of the dilution of the chlorine by nitrogen and air.

The great drawbacks to this process are, first, the quantity of hydrochloric acid (HCl) left undecomposed; second, the great dilution of the chlorine. The consequence is, that most large works—Deacon's own, for instance—use both the Weldon and the Deacon process. It appears to me that the two might be combined to advantage by passing the gas from the Deacon converter through a tower filled with native manganite in lumps, and regenerating the chloride of manganese formed by the action of the muriatic acid left undecomposed in the converters by the Weldon process.

There is one other process in use at Tennant's works in Glasgow—in use at the time I was there, at least—wherein the manganese liquor was precipitated boiling hot, and under some pressure, with powdered limestone. The precipitated carbonate of manganese was then heated on trays in ovens with a supply of air which changed the manganous carbonate to manganic oxide, with the evolution of carbonic acid. This process, however, has not been introduced into the newer portion of Tennant's works, in which Weldon's process has been substituted.

At Tennant's, also, a part of the chlorine was produced by acting on a mixture of salt and nitrate of soda with sulphuric acid. The mixture of chlorine and nitrous acid was passed through strong sulphuric acid, which absorbed the nitrous gas, while the chlorine passed forward to the lime-chambers. The nitrous vitriol was used in the Gay-Lussac towers.—*American Chemist.*

MANUFACTURE OF ORCHIL EXTRACT AND PASTE.

ACCORDING to the process of Saroz and Chognard (French patent) the lichens are macerated for a quarter of an hour in water, to which a little hydrate of lime has been added, and are then heated in a closed vessel to 100° to 120° by the introduction of steam at a tension of several atmospheres. The duration of the heating as well as the temperature are modified according to the kind of lichens made use of. The purpose of this heating is the rapid and complete conversion of the lichen acids into orcine. The clear liquid is then separated from the undissolved woody matter by a filter, a hydro-extractor, or a press, and concentrated by evaporation. It is then mixed with ammonia, and put in a tightly-fitting vessel of iron or wood, into which oxygen is conducted. The formation of orcine is thus more rapid than on the common procedure, in which the extract is left to the action of the atmosphere. The oxygen prepared by the process of Tessié du Motay enters at the bottom of the vessel by means of a perforated tube: the portion not absorbed is conducted away by a second pipe passing through the lid, and may be reserved for a second operation. The evaporating ammonia escapes through the same pipe, and is absorbed in water with a view to its being reutilized. When the oxidation is complete, and the liquid contains an excess of ammonia, it is driven off by exposure to the air or by a gentle heat. To prepare orchil paste, the above-described extract, after concentration and mixture with ammonia, is thickened with a quantity of extracted lichens, and treated with oxygen. The closed vessel is provided with a mechanical agitator. When the oxidization is complete the paste is allowed to stand for some days exposed to the air, with occasional agitation.

PHOSPHINE (PH_3).

THE only method of obtaining absolutely pure phosphine is by the decomposition of phosphonium iodide by water, which yields PH_3 and HI, but very pure phosphine may be obtained by the action of sodic ethylate on P in alcoholic solution. The evolution of gas commences on warming slightly, and will continue regular for some days. From a strong alcohol solution the excess of hydrogen rarely amounts to more than 1½ per cent.

Aqueous and alcoholic solutions of ammonia (nitrine) produce, when digested with phosphorus, mere traces of phosphine, only either at the ordinary temperature or the boiling-point.

Clear phosphorus immersed in strong alcoholic ammonia and exposed to light (direct sunlight when that could be obtained) for a period of nearly six months, yielded only a very small amount of gas containing a trace of phosphine merely, a white crystalline deposit forming on the sides of the glass vessel in very small quantity. (It appears to be only white phosphorus.) Similar formation of crystals was noticed by Commaile.

A smaller amount of similar looking white crystals mixed with red phosphorus formed on the sides of a flask containing aqueous ammonia to which phosphorus had been added

Glycerin does not prevent the formation of the spontaneously inflammable gas when added to the aqueous potash solution used for generating it; even strong glycerin with only 1 to 2 per cent water when treated with potash and phosphorus gives off the spontaneously igniting gas at the ordinary temperature slowly.—*Chemical News.*

PLASTIC SULPHUR.

IT may perhaps be interesting to know that plastic sulphur may be formed at the ordinary temperature. When sulphuretted hydrogen is passed into water containing iodide in suspension, hydric iodide is formed and retained in solution, and a mass of sulphur is formed which may be drawn out into threads, and behaves in all respects like the plastic sulphur formed in the usual way by heat.

The whole of the sulphur is not in the plastic state, there being some ordinary precipitated sulphur intermixed.

The color is light red, due to iodine or probably a sulphur iodide.—*Chemical News.*

DETECTION AND DETERMINATION OF MAGENTA AND ARSENIC IN WINES ARTIFICIALLY COLORED.

By M. C. HUSSON.

THE author places a few drachms of the suspected wine in a phial, and adds a little ammonia, when the mixture turns a dirty green. He then steeps in the liquid a thread of white woollen yarn, withdraws it when saturated, places it vertically, and allows a drop of vinegar to flow along it. If the color of the wine is natural, as the drop advances the wool returns to its original whiteness, but if the wine has been sophisticated with magenta it is dyed of a rose, deeper or paler. He has also examined the physiological action of magenta free from arsenic, and finds that, though not a violent poison, it produces some morbid phenomena. In a state of chemical purity he considers that its use would not occasion any great inconvenience.

RHODEINE, A NEW REACTION OF ANILINE.

By M. E. JACQUEMIN.

THE author having mentioned that the hypochlorites of lime and soda cease to indicate the presence of aniline in solutions containing less than 1 centigrm. in 500 c.c. of water, shows that if after adding the test solution of hypochlorite to these dilute solutions there be further added a few drops of dilute sulphide of ammonium (1 part to 30 of water) a splendid rose coloration appears. In this manner 1 part of aniline may be detected in 250,000 of water. He give the name rhodeine to the coloring matter thus generated. No other oxidizing agent can be substituted for the hypochlorites, and no color is obtained if a sulphite or hyposulphite is used instead of a sulphide. Diphenylamin and toluydin similarly treated produce no such reaction.

ACTION OF SULPHUR UPON PARAFFINS.

By S. CABOT, JR.

HOPING to obtain a sulphur compound of the normal paraffins which might be decomposed with oxide of lead to an oxide, and perhaps be of use in the candle industry, I took for an experiment some pure heptan, C_7H_{16}, prepared by Professor Schorlemmer, of Manchester, from petroleum. This was heated in a flask with a large excess of sulphur. The flask was connected with a return tube cooled with water to prevent the heptan from distilling off and being lost. After five or six hours' heating, this mass began to change in color, and volumes of sulphuretted hydrogen were given off. By continuing the heating the paraffin was almost entirely decomposed. The remainder was examined and proved to contain no organic sulphur compound. The smell was very offensive, but not more so than the combined perfume of H_2S and heptan (petroleum spirit) would produce. The excess of C_7H_{16} was distilled off, and the solid residue was examined by dissolving the sulphur with bisulphide of carbon, which left a black powdery precipitate of carbon. Another portion was heated in a small retort until all the sulphur was distilled off; a black pulverulent residue of carbon was left.

From this experiment it is seen that sulphur at high temperatures decomposes heptan, forming H_2S and carbon. This, I have no question, is the case with all the other members of the group, and I therefore shall not attempt the formation of a sulphur compound of the heavier and solid paraffins.—*American Chemist.*

COMBUSTION OF THE DIAMOND.

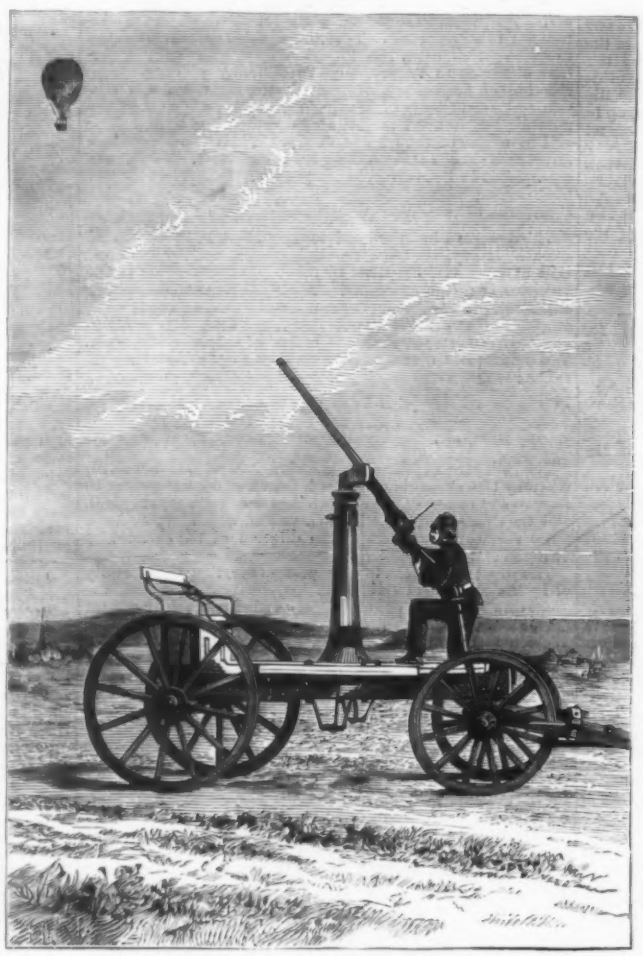
By R. BLINDOW.

THE diamond is placed on a piece of magnesium ribbon, and this on a small bit of clay, and then the whole introduced into a combustion tube. Oxygen is passed through the tube until all the air has been driven out, and that part of the tube at which the diamond is situated is heated. The magnesium takes fire, and the diamond itself also burns slowly. The vapors formed are conducted into lime-water.

KRUPP'S BALLOON MUSKET.

OUR illustration represents a curious weapon, made for the first time during the Franco-Prussian war, and devised by the celebrated German iron founder, Herr Krupp, at the request of Field-Marshal Von Moltke. It was intended to stop the balloon post, which it will be remembered was the only means of communication between Paris and the outer world during the protracted siege of that city. The weapon is an overgrown musket arranged and balanced on a standard so as to have free vertical as well as horizontal sweep, so that the artillerist can easily direct it toward any point in the sky. It was mounted on an artillery wagon, which was very strongly constructed, and to which two fast horses could be attached, so that the course of the air-ship which formed the target could be swiftly followed, or its path intercepted.

All knowledge of this gun must have been carefully concealed from the French, for *La Nature* publishes the engraving as a curiosity, and mentions never having had any definite previous information of the weapon, although it appears that the Parisian aeronauts were often sorely puzzled to know what manner of fire-arm their enemies possessed, which could throw huge bullets a height of 3200 feet into the air. The Germans, however, were better posted as to French affairs, for they knew the diameter of every balloon made in the city long before any were dispatched, probably through their elaborate secret spy system. Consequently the instant an air-ship was seen rising over the Parisian mansards, the Prussian vedettes noted the direction it was taking, also the name on the globe, and other points, and telegraphed the information to the rear. Immediately on the reception of the message, the balloon gun-carriage would start (the horses being constantly kept harnessed) at a tearing gallop across the country to head off the balloon. As soon as the latter was sighted, the artillerist being informed of the diameter, could easily approximate its distance off, and so direct his piece with reasonable accuracy. The first intimation the aeronauts would have of the fact that their craft had excited interest in the Prussian camp would be a ball whizzing past them, followed by others. If ballast could be thrown out quickly enough, the balloon might rise out of range; if not, the moment a bullet went through the silk cover the adventurous voyage was ended, and a squad of mounted Uhlans would dash off to capture both balloon and aeronauts on their reaching *terra firma*. In this way quite a number of balloons toward the end of the siege were intercepted, and the balloon gun at the same time was brought to a remarkable state of perfection. Of the details of the weapon, our contemporary speaks not, probably because that information its German owners keep to themselves.



PRUSSIAN BALLOON MUSKET.

ANALOGY OF SOUND AND LIGHT.

A LECTURE recently delivered at the Loan Exhibition, South Kensington, by Professor Barrett, of the Royal College of Science, Dublin, deals with one of the most interesting phases of science. In commencing the lecturer referred to some well-known facts about light and sound, such as that sound-waves travel through air, while light-waves travel through "luminiferous ether." Among other illustrations of the rate at which each travels he gave this as a very intelligible one: If a cannon were fired in London the sound would take about eight minutes to travel to Birmingham, a little over 100 miles, while in the same time the light from the flash would have travelled to the sun, a distance over ninety millions of miles. But though they so differ in the rate of progress, both light and sound show many phenomena in common. In the experiments made during the evening the sensitive flame was used as a detector of sound. This delicate acoustic reagent, familiar to London audiences through Professor Tyndall's lectures, was first, we believe, discovered in 1866 by Professor Barrett, though he modestly did not allude to the fact. The performance of the experiments, however, was entirely new to a London audience. The analysis of the phenomena of light and sound were illustrated in the following order: (1) Both light and sound get feebler as they leave their source of origin. In the case of sound this was shown with a loud-ticking watch and a sensitive flame; (2) in reflection the angle of incidence is the same as the angle of reflection. In the case of sound this was shown with the sound of a whistle sent along a tube, and reflecting along another placed at an angle to it from a reflector placed at the end where they approached. The distance to which a feeble sound might be reflected perceptibly from a concave mirror, was shown with mirrors over 30 feet apart. (3) With refraction, in the case of light, familiar convex lenses were used, and in the case of sound analogous but less familiar lenses of gas of a different density from air were used. A collodion balloon, filled with carbonic-acid gas, served as a double convex lens, and its action was manifested by the concentration of sound from the ticking watch on to the sensitive flame. (4) Both light and sound suffer absorption in passing through non-homogeneous media. Professor Tyndall's apparatus showing the "echoing back" of sound in passing through successive alternating layers of gas of different densities is now well known, and every one is familiar with the fact that though light may traverse a vessel of clear water, it can no longer travel when it is filled with bubbles of transparent air. (5) There is an analogy between the sympathy among the same notes of a gamut and the sympathy among individual colors in the spectrum. An incandescent body that produces a particular bright band in the rear of the spectrum, will, when in a gaseous state, absorb light and cause a dark band in exactly the same part of the scale. Tuning forks, wire, or columns of air in jars are responsive to vibrations produced by others exactly in unison, but only to those. This was shown in various ways in a very clear manner. (6) An analogy, which Professor Barrett called a more fanciful one, was spoken of. All the complex music of an orchestra is the result of a few simple notes variously combined. So all the tints of a picture are the results of a few simple colors variously combined. The musical scale sorts the complex notes in one case, the spectrum sorts the complex colors in the other. Professor Barrett, taking Professor Listing's determinations of wave-lengths, has made a most interesting comparison. The wave-lengths of the notes of the gamut he expresses not in absolute but in relative measurement. Thus C is taken as 100, and all the other notes have their wave-lengths expressed in percentages. Similarly red is taken at 100, and the wave-lengths of other colors are expressed in percentages. This interesting result comes out in comparing the two columns. D and orange are each 89; E and yellow, 80; F and green, 75; G and the average of the blues, 67; A and violet, 60; B and ultra-violet, 53; C and the obscure rays (black), 54. Further, the comparison of harmonies comes out in an interesting manner. Low C and upper C sound well together, so red and black go well together. Red and green, and C and F harmonize well, but red and orange no lady would wear, and C and D make a combination by no means pleasant. Red and blue, or C and G, also go well together. (7) The concluding part of the lecture was devoted to an illustration of figures described by vibrating bodies. Several apparatus for this purpose were referred to, but especial attention was given to an apparatus of great ingenuity devised by Mr. F. S. Pichler. Professor Barrett showed it with an electric light and a reflection on to a screen. The principle of it may be thus described: Two metallic vibrators, each with a small speculum, are fixed at right angles to each other, and sounds are produced by a current of air acting on one or both of them at pleasure. The perpendicular vibrator is tuned to a given note; the horizontal vibrator is fitted with a mechanical arrangement whereby its pitch can be graduated to any degree of nicety within the compass of two octaves. An apparatus is also provided whereby a pencil of light is concentrated upon the speculum of the perpendicular vibrator, whence it is reflected to the speculum of the horizontal vibrator. For lecture purposes artificial light is used, which is further reflected and magnified upon the screen. When musical sounds are produced by the vibrators, various luminous geometrical figures are formed on the horizontal speculum and reflected on the screen, by the single or joint action of the vibrators described by the pencil of light; and the form and motion of such figures demonstrate the exact relations to each other of the musical notes produced. Sounds which harmonize to the ear produce regular figures to the eye, as, for example, segments of the circle, ellipses, ovals, circles, or straight lines; and if the amplitude of each vibrator be equal, these luminous figures will hover on the speculum or screen, with an apparent steadiness, like that of the heavenly bodies hovering in the sky. If the sounds do not harmonize, the figures are confused, unsteady, and complicated, presenting an appearance as if the wave-lines were contending with each other. The mathematical relations of musical notes are also demonstrated, regular simple forms being produced by combinations of these notes which result from vibrations bearing a different numerical ratio to each other, while irregular and unsteady figures are caused by notes which have no such ratios. The patterns made on the screen by a discord are very bewildering to the eye.

Professor Barrett, in concluding, said after seeing how musical notes may be translated into moving lines of light, the words put by the poet into the mouth of Lorenzo have additional interest:

> "There's not the smallest orb which thou behold'st,
> But in his motion like an angel sings."

GROWTH OF THE EARTH.

By C. A. YOUNG, LL.D., Professor of Astronomy in Dartmouth College.

SINCE meteoric matter is continually falling upon the earth, she must of course be growing larger, and the daily number of meteors is so immense that it would be natural to suppose that the increase might be quite appreciable in a few centuries. It is not so, however; the surface of the earth is so enormous, compared with the quantity of meteoric matter, that even on the most favorable hypotheses, her diameter would grow only about an inch in five hundred million years by accessions of this kind.

A few figures will make this clear.

As to the number of visible meteors there is substantial agreement among authorities. The estimate of Professor Newton is as large as that of any one, I believe, and he puts it at 7,500,000 per diem, which number we will use.

As to their average weight there is more difference of opinion. Probably, however, the most careful and best founded investigation is that of Professor Harkness, published in his report upon observations of the November meteors of 1866, and his conclusion is that "the mass of ordinary shooting stars does not differ greatly from *one grain*." Professor Newcomb appears also to concur in this estimate. There are reasons which it would take too long to discuss, for thinking that this value is likely to be somewhat too small; but on the other hand it is almost absolutely certain that the average mass can not be as great as one fourth of an ounce. To be on the safe side, we will assume 100 grains as the mean weight of the visible shooting stars.

Remembering that the pound is 7000 grains, we shall then find nearly 107,000 pounds, or about 50 tons, for the total weight of one day's supply of shooting stars. An allowance must also be made for the meteors too small to be visible (which are known by telescopic observations to be very numerous), and for the matter brought down by aërolites. If we double the quantity stated above we shall certainly be abundantly liberal, and this will give us 214,000 pounds a day, or about 78,164,000 pounds per year, as the earth's rate of growth *in weight*.

Her increase of *bulk* depends upon the density of the meteoric matter, and probably this density does not differ much from that of ordinary soil, or nearly three times that of water. If so, each cubic foot would weigh about 187½ pounds, and the annual meteoric accession to the bulk of the earth would be not far from 417,000 cubic feet. A cube about 75 feet on each side would be a little larger. It would take more than four million such to make a pile as large as Mount Washington. Now, since the surface of the earth is about 5484 millions of millions of square feet, it follows that the annual supply of meteoric matter, if spread uniformly, would form a layer whose thickness would be only $\frac{1}{13150000000}$ a foot, or very nearly $\frac{1}{1100000000}$ of an inch. In other words, even on such extravagantly favorable hypotheses as we have assumed, the formation of a sheet of meteoric matter covering the earth to a depth of one inch would require a period of eleven hundred millions of years.

If we suppose meteoric matter to have been just as abundant in space as now since the beginning of time, and that the velocity of the earth's orbital motion has remained unchanged, and that the effects of her atmosphere and of her gradual shrinkage under the action of gravity can be neglected, then it can be shown by an easy course of reasoning, which would, however, hardly suit these columns, that her diameter must have grown during her whole existence at the same uniform rate as now, and we find that to build her up to her present dimensions by such a process of aggregation must have taken a period of at least twenty-seven and a half millions of millions of years.

It is not intended to assert, however, that the earth was really formed in this way, and even if it was, the above estimate is of little value except as indicating the order of magnitude involved, since there is no certainty whatever—not even a probability—that in the early stages of the formation of the planetary system circumstances nearly enough resembled the present to warrant any conclusion. Nor must it be forgotten that the more probable estimates of Harkness and others as to the weight of meteors would lengthen all the periods of time mentioned from ten to one hundred fold; we have given the smallest values possible.—*Boston Journal of Chemistry.*

KRUPP'S STEEL CANNON WORKS.

A CORRESPONDENT of the Augsburg *Gazette*, who has paid a visit to the Krupp establishment at Essen, says that the number of workmen employed in the steel foundries is 10,500, and in the mines and the iron forges 5000. In the steel factory there are 1648 furnaces of various kinds in full blast, 208 steam-boilers, 77 steam-hammers, 294 steam-engines, from one to two thousand horse-power, and 1093 other machines. In the year 1875 the manufactory consumed 612,000 tons of coal, 4,500,000 cubic metres of water, 7,700,000 cubic metres of gas, supplying 22,432 burners. The means of transport and communication comprise 25 miles of railway, with 14 engines and 537 trucks; 11 miles of narrow-gauge rails, with 10 engines, 210 trucks, 80 horses, and 214 wagons, and 38 miles of telegraphic wires. The number of men employed is 16,200, and they have 3277 dwelling-houses. The food-supply department comprises an hotel, 3 breweries, a mineral-water factory, a butcher's shop, and a bake-house with a steam mill for grinding the corn. The bake-house turns out 200 tons of bread in a month, and the total monthly receipts for the whole supply department are £13,500. The mining department sees to the working of the 414 shafts which are being worked in Germany, exclusive of those belonging to the Krupp Company in the North of Spain, the minerals from which latter place are conveyed in four steamers with a total tonnage of 1700 tons. The practice ground for the guns made at Essen is at Dülman, and it is nearly five miles long.

THE PRESSURE OF SUNLIGHT.

PROF. CLERK-MAXWELL says: "The mean energy in one cubic foot of sunlight is about 0.0000000882 of a foot-pound, and the mean pressure on a square foot is 0.0000000882 of a pound weight. A flat body exposed to sunlight would experience this pressure on its illuminated side only, and would therefore be repelled from the side upon which the light falls. Calculated out, this gives the pressure of sunlight equal to about two and a half pounds per square mile. Between the two and a half pounds deduced from calculation and the fifty-seven tons obtained from experiment the difference is great, but no greater than is often the case between theory and experiment.